Volume 22, Number 23, December 15, 1968

NUCLEAR SCIENCE ABSTRACTS

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Published by the USAEC Divison of Technical Information Extension, Robert L. Shannon, Extension Manager.

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Index References

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  Radioactive chain of mass number 189,  21:10023
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Personal Authors

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MONTH, M.
  Theory of gradient perturbations in AGS,  21:9872 (BNL-
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MONTH, Melvin
  Simple relativistic calculation of the electromagnetic
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SHEEP
  radiation dosimetry in, measurement of lethal dose of x,
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    21:8560 (URS-658-3)
  fire resistance of components of, evaluation of,
    21:8789(R) (AD-642241)
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8500 (Y-1561) MIXING AND SAMPLING ENRICHED ^{235}U FLUIDS IN CYLINDRICAL STORAGE CONTAINERS. Final Report. Harrell, J. E. **(Union Carbide Corp., Oak Ridge, Tenn. Y-12 Plant).** Jan. 17, 1967. Contract W-7405-eng-26. 124p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

is indexed as:

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UNION CARBIDE CORP., OAK RIDGE, TENN.  Y-12 PLANT.
  Mixing and sampling enriched 235U fluids in cylindrical
    storage containers,  21:8500 (Y-1561)
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  3311(Suppl. 2)  21-8567   Dep. mn. CFSTI $3.00 cy, $0.65 mn
  22298           21-9915   Nucl. News, 9: No. 12, 17-21 (Dec.
                              1966)
  22298           21-9914   Nucl. News, 10: No. 1, 17-20(Jan.
                              1967)
  23267           21-9702   Phys. Rev., 152: 1171-82(Dec. 23,
                              1966)
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NUCLEAR SCIENCE ABSTRACTS

CHEMISTRY

Analytical Chemistry

Refer also to abstracts 48917, 48940, 49111, 49270, 49410, 50151, and 50487.

48810 (AERE-R-5799) A VERSATILE SPECTROGRAPHIC METHOD FOR THE ANALYSIS OF A WIDE RANGE OF MATERIALS. Webb, M. S. W.; Wordingham, M. L. (Atomic Energy Research Establishment, Harwell (England)). June 1968. 27p. Dep. CFSTI. UK 4s. 6d.

The development of a sensitive and versatile spectrographic method for the analysis of a wide range of small samples (1.5 mg) is described. The sample is mixed with a buffer consisting of a mixture of lithium fluoride and graphite and burnt in a dc arc with anode excitation. Cobalt is used as an internal standard. Sensitivities corresponding to a sample weight of 1.5 mg vary according to impurity element from 1 to 100 ppM. Coefficients of variation for single exposures at the 100 ppM level of between 5 and 10% were obtained for many elements. (auth) (UK)

48811 (ANL-7402) LABORATORY INVESTIGATIONS IN SUPPORT OF FLUID-BED FLUORIDE VOLATILITY PROCESSES. PART XVIII. NEUTRON COUNTING AS AN ANALYTICAL METHOD FOR PLUTONIUM FLUORIDES. Shinn, William A.; Steindler, Martin J. (Argonne National Lab., Ill.). Apr. 1968. Contract W-31-109-eng-38. 52p. Dep. CFSTI.

Counting of neutrons generated in plutonium fluorides was investigated as a method of quantitatively determining plutonium hexafluoride (PuF_6) as well as plutonium tetrafluoride (PuF_4) alone or mixed with alumina or sodium fluoride (NaF). The plutonium fluorides were obtained by processing simulated, spent reactor fuels by the fluid-bed fluoride-volatility process. With a water-moderated detector employing four proportional counters filled with 10 atm of helium-3 (^3He), 31.8 counts/(min)(mg PuF_4) were detected, corresponding to about 15% of the neutrons emitted from PuF_4. This sensitivity allows milligram quantities of plutonium fluorides to be determined rapidly and precisely with the accuracy limited by the specific neutron activity of the sample. Neutron activity of a plutonium compound, from the (α,n) reaction with fluorine, varies with the alpha activity of the sample, the type of diluent (alumina or NaF), and the size of particles in the mixtures. Neutron counting rates of plutonium dioxide (PuO_2) and uranium tetrafluoride (UF_4) are detectable with the water-moderated detector, although yields of only 0.448 count/(min)(mg PuO_2) and 1.6×10^{-4} count/(min)(mg UF_4) are obtained. Portable neutron detectors, including several scintillators and a small counter using a ^3He tube, were assembled and tested for use in surveying process equipment. For all the scintillators except one, gamma rays cause interference to an extent that prevents practical shielding. The exception is the scintillator using ^6Li glass for which gamma shielding may be practical if further development of neutron shielding for directional response is effective. Results obtained with two configurations of the ^3He detector in paraffin-cadmium neutron shields indicate that a moderately directional response can be obtained with a portable neutron detector. With a plutonium fluoride source, directional response having a ratio of maximum to minimum counting rate as high as 6.3 can be achieved with a shielded ^3He detector weighing 27 lb. (auth)

48812 (CEA-R-3557) ANALYTICAL PROCEDURES USED BY THE GEOCHEMISTRY SECTION FOR URANIUM, RADON, AND RADIUM. Berthollet, Pierre (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). June 1968. 54p. (In French). Dep.

The analytical methods described are applied to the geochemical prospecting of uranium. The nature of the material under investigation, which may be soil, alluvium, rock, plant or water, and the particular requirements of geochemical exploration, prompted an adjustment of the widely used conventional methods to the demands of large scale operation, without lowering their standards of accuracy and reliability. These procedures are explained in great detail. (auth)

48813 (DP-1150) THE MICRO-DETERMINATION OF CARBON, HYDROGEN, AND NITROGEN IN ORGANIC AND ORGANOMETALLIC COMPOUNDS. Gaddy, R. H. (Du Pont de Nemours (E. I.) and Co., Aiken, S. C. Savannah River Lab.). Sept. 1968. Contract AT(07-2)-1. 12p. Dep. CFSTI.

Carbon, hydrogen, and nitrogen in a variety of unusual organic and organometallic compounds were determined accurately and precisely with a commercial instrument consisting of a high-temperature combustion furnace coupled with a gas chromatograph and equipped for automatic operation. (auth)

48814 (DP-1164) DETERMINATION OF MERCURY IN RADIOACTIVE SAMPLES BY FLAMELESS ATOMIC ABSORPTION SPECTROPHOTOMETRY. Wheat, J. Allen (Du Pont de Nemours (E. I.) and Co., Aiken, S. C. Savannah River Lab.). Aug. 1968. Contract AT(07-2)-1. 10p. Dep. CFSTI.

A flameless atomic absorption technique was adapted for determination of mercury in highly radioactive samples. Mercury is isolated on a small copper coil by spontaneous displacement from acid solution and is then vaporized by resistance heating in an evacuated cell in the light path of an atomic absorption spectrophotometer. The mass of mercury vapor is determined by attenuation of characteristic mercury radiation. Concentrations of mercury as low as 10^{-5}M in solutions containing as much as 10^{12} d/(min)(ml) of alpha activity and 10^{12} c/(min)(ml) of beta-gamma activity were determined with precisions of about 5%. The method was used successfully to trace the path of mercury in plant processes and to determine the concentration of mercury in plant product. (auth)

48815 (FOA-4-4363) DETERMINATION OF 0.1-0.5 MMOLE FLUORINE BY WILLARD-WINTER DISTILLATION AND TITRATION WITH THORIUM NITRATE. Andersson, L. H.; Gelin, B. (Forsvarets Forskningsanstalt, Stockholm (Sweden)). June 1968. 24p. (In Swedish). Dep.

Tests are reported on the precision of determination of fluorine in the range 0.1 to 0.5 millimole. The fluorine was separated by Willard–Winter distillation and then titrated with thorium nitrate. A distillation apparatus for use in glove boxes is described. In the investigated fluorine amount range a standard deviation for a series of 15 experiments of 1.9×10^{-3} millimole was obtained. In the case where the silicic acid was removed from the distillate by ion exchange the standard deviation for a set of 15 experiments was 2.8×10^{-3} millimole. Uranyl and plutonyl ions were found not to interfere with the separation. On the other hand aluminum ions prevented complete separation. (Sweden)

48816 (K-L-2165) MASS SPECTROMETER FOR ISOTOPIC ANALYSIS OF BORON TRIFLUORIDE. Creswell, H.; Horton, J. C.; Langdon, A.; Sulfridge, C. (Oak Ridge Gaseous Diffusion Plant, Tenn.). Dec. 30, 1965. 67p. Dep. CFSTI.

The instrument is a 6-in. radius isotope mass spectrometer

modified for automatic operation and equipped with a molecular beam source assembly. Component descriptions, operating procedures, and guides for locating and repairing defective components are presented. (M.C.G.)

48817 (MLM-1542) COLORIMETRIC DETERMINATION OF ZIRCONIUM IN THE PRESENCE OF PLUTONIUM AND URANIUM WITH ALIZARIN RED-S. Bishop, C. T.; Yates, W. G.; Redding, P. L.; Sellers, D. E. (Mound Lab., Miamisburg, Ohio). Sept. 24, 1968. Contract AT(33-1)-Gen-53. 9p. Dep. CFSTI.

Zirconium can be determined colorimetrically in the presence of plutonium and uranium by the formation of a zirconium-alizarin red-S complex, which absorbs at 525 mμ. The acid concentration of solutions taken for analysis must be greater than 2M to prevent hydrolysis of zirconium, but the solution in which the zirconium alizarin red-S complex is formed must be 0.15 to 0.25M due to a decrease of absorbance at higher acid concentrations. Up to 6 mg of plutonium and even greater amounts of uranium (200 mg) per 25 ml of solution may be present provided mercaptoacetic acid is added to reduce the plutonium to the tripositive oxidation state. Although the colorimetric determination of zirconium in the presence of plutonium and uranium is not as precise as other qualitative techniques, the method is readily adaptable to radioactive glovebox operations. (auth)

48818 (NIM-244) DETERMINATION OF SELENIUM AND TELLURIUM IN SILVER CHLORIDE AND URANIUM COMPOUNDS. Jones, Elaine A.; Russell, B. G.; Steele, T. W. (National Inst. for Metallurgy, Johannesburg (South Africa)). Oct. 26, 1967. 9p. Dep.

After dissolving the sample, Se and Te are separated by precipitation in strongly alkaline solution with Ag_2O as a collector for the Te. The Se passes into the filtrate and is separated from interfering substances by precipitation with $Al(OH)_3$ as a collector. The Se is then determined spectrophotometrically with 3,3'-diaminobenzidine after extraction into toluene. The Te is separated from interfering substances by coprecipitation with $Fe(OH)_3$ and elution through a cation exchange resin. It is determined spectrophotometrically with sym-diphenylthiourea. (M.C.G.)

48819 (NIM-256) DETERMINATION OF CARBON IN URANIUM TETRAFLUORIDE. Austen, C. E.; Stoch, H.; Steele, T. W. (National Inst. for Metallurgy, Johannesburg (South Africa)). Nov. 8, 1967. 9p. Dep.

A method was developed for the determination of more than 10 ppM carbon in UF_4. After drying at 110°C the UF_4 is heated in a stream of oxygen in a combustion tube. The fluorine evolved is absorbed by MgO. The CO_2 formed is absorbed in a dilute NaOH solution and determined conductometrically. (M.C.G.)

48820 (NP-17627) REFERENCE METHODS FOR REFRACTORY METALS ANALYSIS. Miller, G. L. (ed.) (Advisory Group for Aerospace Research and Development, Paris (France)). 1966. 80p.

Methods for analysis of refractory metals for impurities are described. The analytical methods are listed in alphabetical order of the elements concerned: Mo, Nb, Ta, and W. (M.C.G.)

48821 SPECTROPHOTOMETRIC STUDY OF SOLUTIONS OF THE TUNGSTEN(VI) AND MOLYBDENUM(VI) COMPLEX COMPOUNDS WITH PYROCATECHOL IN THE PRESENCE OF COMPLEXONE III. Busev, A. I.; Sokolova, T. A. (Moscow State Univ.). Zh. Anal. Khim., 23: 1348-54(Sept. 1968). (In Russian).

The behavior of solutions containing tungstate and molybdate ions and two ligands (pyrocatechol and Complexone III), when two competing complex forming processes take place, was studied spectrophotometrically. At pH 5.2 to 5.5 and a pyrocatechol concentration of 3.6×10^{-2}M Complexone III (of which the total concentration in the solution is 2.7×10^{-2}M) masked reasonably well 1 to 5 mg of molybdenum(VI) in 25 ml. Molybdenum existed in the solution mainly as a compound with Complexone III. Tungstate ions under the above conditions (the pH value, the concentrations of pyrocatechol and Complexone III) existed in the solution mainly as pyrocatechinate, which permitted the spectrophotometric determination of tungsten. A method of calibration graphs and a differential method were used for determining tungsten in the presence of molybdenum (the molybdenum content was found beforehand as a molybdenum(V) compound with Complexone III). Artificial mixtures of $Na_2WO_4 \cdot 2H_2O$ and $Na_2MoO_4 \cdot 2H_2O$ at different ratios of tungsten to molybdenum (from W:Mo ≈ 5:1 to W:Mo ≈ 1:10) were analyzed. A reasonably rapid (about 30 min) determination of molybdenum and tungsten in solution is possible using Complexone III, pyrocatechol, and hydrazine sulfate. The method suggested can be used for the analysis of binary Mo-W alloys and salt mixtures containing tungsten and molybdenum in commensurable amounts. (auth)

48822 POLAROGRAPHIC DETERMINATION OF URANIUM(VI) IN THE AQUEOUS PHASE AFTER ITS EXTRACTION WITH TRIBUTYL PHOSPHATE. Palei, P. N.; Sklyarenko, I. S.; Gusev, N. I.; Radionova, N. S. (Inst. of Geochemistry and Analytical Chemistry, Moscow). Zh. Anal. Khim., 23: 1355-8(Sept. 1968). (In Russian).

A method is suggested for the quantitative determination of uranium(VI) in aqueous nitric acid solutions after extraction with a solution of tributyl phosphate in CCl_4 in the presence of certain amounts of Fe, Pb, Cu, and Cr. Effects of HNO_3 concentration on results of the uranium(VI) determination in the presence of small amounts of tributyl phosphate were studied. (auth)

48823 CATALYTIC WAVE OF HYDROXYLAMINE IN THE PRESENCE OF NIOBIUM(V) AND THE POSSIBILITY OF ITS USE FOR THE DETERMINATION OF NIOBIUM. Sinyakova, S. I.; Stepanova, I. K. (Inst. of Geochemistry and Analytical Chemistry, Moscow). Zh. Anal. Khim., 23: 1405-7(Sept. 1968). (In Russian).

A study was made of the increase in electric current appearing in HCl solutions containing hydroxylamine hydrochloride and niobium(V). Its catalytic nature was established. Down to 1×10^{-7}M niobium was determined by the increase in current of hydroxylamine in a supporting electrolyte containing 10M H^+ and 4M Cl^-. The accuracy of the method is satisfactory. (auth)

48824 ELECTROCHROMATOGRAPHIC METHOD AIDS DETERMINATION OF TRACE LEVELS OF BARIUM, STRONTIUM, AND LANTHANIDES. Welford, G. A.; Chiotis, E. L.; Morse, R. S. (Atomic Energy Commission, New York). Chem. Eng. News, 45: 48-9(1967).

The technique is based on the fact that a labeled precipitant migrates faster on a paper strip than does the stable element. Measurements are made by radiometric techniques, and μg amounts of the metals can be determined with a precision of ≃±10%. (Anal. Abstr.)

48825 AMPEROMETRIC DETERMINATION OF SMALL AMOUNTS OF THORIUM. I. AMPEROMETRIC TITRATION WITH POTASSIUM FERROCYANIDE OR OXALIC ACID. Khadeev, V. A.; Masalova, L. S. Tr. Tashkent. Gos. Univ., No. 288, 3-11(1967). (In Russian).

Amperometric and biamperometric titration of Th with $K_4Fe(CN)_6$ solution is carried out in 0.01N to 0.04N HNO_3 at a platinum indicator-electrode potential of +1.0 V (vs a S.C.E.) and E = 0.05 to 0.1 V. The sensitivity of the method is 0.004 mg per ml. There is interference from EDTA, Ce^{4+}, Fe^{3+} and other ions that are precipitated by $[Fe(CN)_6]^{4-}$. The amperometric titration of Th with oxalic acid solution by using the current due to oxidation of the titrant is carried out at E = 0.9 V in 0.05N to 0.1N HCl or HNO_3. There is interference from SO_4^{2-}, citrate, EDTA, Sb, Mo, Fe, and Zr. In the presence of Cu or Al, glycine or an excess of tartaric acid, respectively, must be added. The titration with oxalic acid solution is more selective but less sensitive than that with $K_4Fe(CN)_6$. (Referat. Zh.)

48826 ABSORPTIOMETRIC DETERMINATION OF ZIRCONIUM IN ORES. Abdurakhmanov, M.; Dzhiyanbaeva, R. Kh.; Talipov, Sh. T. Tr. Tashkent. Gos. Univ., No. 288, 83-6(1967). (In Russian).

In acid medium (pH 0 to 3.5) N-methylanabasine-α'-azo-β-naphthol {1-[3-(1-methyl-2-piperidyl)-2-pyridylazo]-2-naphthol} (I) forms with Zr a 4:1 colored complex suitable for absorptiometric determination. The molar extinction coefficient of the complex is ≃5000 and Beer's law is obeyed with 10 to 50 μg of Zr in 25 ml. To the Zr solution (as sulfate) add 1 ml of 1% gelatin solution, 10 ml of buffer solution of pH 1 0.2N-HCl-0.2N-KCl) and 5 ml of 0.2% ethanolic I solution, dilute the mixture to 25 ml, and measure the extinction at 562 nm. There is no interference from the following (tolerable amounts, relative to Zr, are given in parentheses) — Al, Mg, Cd, Mn, UO_2^{2+}, Th, Be, Zn, Sr, Ca, Hg, and Ga (20 to 300); Ce and Fe (10), Ni (5), W (2), and Cr^{VI} (6); Cu is masked with thiourea, and Fe^{3+} is reduced with ascorbic acid. The Zr-I complex is stable in a solution 0.6N in HCl, whereas the Hf-I complex is decomposed; this was used to determine Zr in the presence of Hf (up to a ratio of Zr to Hf of 1:2). The method has been tested on Zr-Mg and Zr-Al-Ni alloys, and on ores. (Referat. Zh.)

48827 DETERMINATION OF NIOBIUM AND TANTALUM. Mayer, V. (VZKG, Ostrava, Czech.). Hutn. Listy, 22: 122-6(1967). (In Czech).

Gravimetric, titrimetric, spectrophotometric, polarographic, spectrographic, radiochemical, extraction and ion-exchange methods for the determination of Nb and Ta are reviewed. (41 references.) (Anal. Abstr.)

48828 RADIOMETRIC ASSAY OF SHORT-LIVED ISOTOPES. Marais, P. G.; Haasbroek, F. J.; Karsten, J. H. M.; van R. Smit,

J. (Fruit and Food Tech. Research Inst., Stellenbosch, S. Africa). S. Afr. J. Agr. Sci., 10: 135-41(1967).

Counting rates of ^{137m}Ba sources were determined with a scintillation counter and a Geiger–Mueller tube. A simplified equation was devised for conversion of values thus obtained into true instantaneous rates. The theoretical conversion factor yielded values in close agreement with experimental observations even under conditions in which the counting periods were 8 times the half-life and counting rates were associated with resolving-time losses of 50%. (Anal. Abstr.)

48829 DETERMINATION OF MOLYBDENUM, IRON, AND TITANIUM IN ORES AND ROCKS BY PORTABLE RADIOISOTOPE X-RAY FLUORESCENCE ANALYSER. Gallagher, M. J. (Inst. of Geological Science, London). Inst. Mining Met., Trans./Sect. B, 76: 155-64(1967).

The analyzer previously described (Bowie et al., Analyt. Abstr., 13: 5322(1966); Darnley and Gallaher, Ibid., 14: 3220(1967)) is now available commercially. The sources ^{109}Cd (2 mC) and ^{55}Fe (1 mC) are used to excite Mo and Ti K x rays, respectively, and Fe K x rays are excited by either ^{3}H–Zr (15 curies) or ^{238}Pu (20 mC). Balanced filters are normally used for energy selection, but unfiltered x radiation is also used to provide a direct measure of Fe and Ti contents. The accuracy of determinations on groups of powdered samples of relatively low metal content is within 0.02 to 0.03% for MoS_2, within 0.5 to 2.0% for Fe, and within 0.2 to 1.0% for TiO_2 (95% confidence limits). Variations due to counting statistics affect the accuracy only in the analysis of samples with very low contents of Ti and Mo. (Anal. Abstr.)

48830 APPLICATION OF β-RAY BACK-SCATTERING ANALYSIS TO THE SYSTEMS LEAD(II)–SILVER(I), LEAD(II)–COPPER(II), AND COPPER(II)–SILVER(I). Calu, N.; Cecal, A. (Univ. Al. I. Cuza, Iasi). An. Stiint. Univ. Al. I. Cuza, Iasi, Sect. I, 13: 23-8(1967). (In Rumanian).

The variation with concentration of the intensity of backscattered β radiation was studied for solutions (up to 30%) of $Pb(NO_3)_2$, $AgNO_3$, and $Cu(NO_3)_2$. The intensity increased with increasing concentration and varied rectilinearly with the fictive atomic number of the metals in the test solution. The relationships found permitted the construction of calibration graphs that were accurate to within ±0.5% at salt concentrations of 10 to 20%. Calibration for analysis of binary mixtures to within ±1% was also possible. The method is thus applicable to solutions (in HNO_3) of binary, ternary, or quaternary (white metal) alloys. The use of high-intensity ^{204}Tl sources is recommended. (Anal. Abstr.)

48831 DETERMINATION OF SULFUR IN PETROLEUM PRODUCTS BY FAST-NEUTRON ACTIVATION AND THE INTERFERING ELEMENTS. Tamura, Mitsuhisa (Government Resources Research Inst., Kawaguchi, Japan). Radioisotopes (Tokyo), 17: 423-7(Sept. 1968). (In Japanese).

A rapid nondestructive method to determine sulfur in petroleum products with 14 MeV neutrons was reported previously. The correction for oxygen, the predominant interfering element, was made, but the results showed a little positive bias. Further experiments with the error are described, together with a counting technique and the precisions. In the case of middle east crude oils, nitrogen made a contribution to the bias. This was experimentally confirmed by the decay curves for three crude oils (Gach-Saran, Kuwait, and Khafji) and three commercial products (gas oil, and light and medium fuel oils) and by their spectra. Accordingly, a counting technique which chiefly reduces the effect of nitrogen was adopted. The biases observed in this way are +0.06%S for the gas oil, +0.09%S for the light fuel oil, and +0.11%S for the medium fuel oil. The relative standard deviations are 2.4% for the medium fuel oil containing 2.40%S and 7.4% for the gas oil containing 0.54%S. (auth)

48832 RED CELL SURVIVAL TIME IN MAN MEASURED BY ^{50}Cr AND ACTIVATION ANALYSIS. Donaldson, G. W. K.; Johnson, P. F.; Tothill, P.; Richmond, J. (Royal Infirmary, Edinburgh). Brit. Med. J., 1: 585-7(June 8, 1968).

The use of ^{50}Cr and the application of activation analysis to the determination of the red cell survival time is reported. The patient's blood was incubated with nonradioactive sodium chromate at room temperature, the concentration of elemental Cr being less than 10 μg/ml of red blood cells, a concentration believed not to affect red cell survival. The red cells were then washed twice in normal saline and resuspended in saline before intravenous infusion. Blood samples were taken subsequently from the patient every few days for up to 30 days for Cr activation. Chromium-50 was activated by thermal neutrons to the radioisotope ^{51}Cr. After freeze-drying the red cells were exposed in a reactor to a neutron flux of 10^{12} thermal neutrons/cm^2 sec for from 12 to 20 hr. The blood samples were then left for 2 weeks to allow decay of the short half-life radioactive nuclides, such as ^{24}Na (half-life 15 hr) and ^{42}K (half-life 12.5 hr). The ^{51}Cr content of the activated blood was determined by pulse height analysis of the γ spectra of the blood samples. The amount of ^{51}Cr present was taken from the area under the peak at 0.32 MeV. The fall in the ^{50}Cr content of serial blood samples from each patient was then determined by similar measurements of the ^{51}Cr peaks produced by activation, and the $T_{\frac{1}{2}}$ for ^{50}Cr calculated as the time in days for the ^{50}Cr content to fall to 50% of the original amount. When ^{50}Cr and ^{51}Cr were used simultaneously, the radioactivity in the blood samples due to ^{51}Cr was first estimated and allowed to decay before the samples were placed in the reactor for activation. The method allows the determination of the red cell survival time without exposing the patient to radiation, a factor which might be important in pregnant women and children. (BBB)

48833 RELIABILITY OF THE FILTER TECHNIQUE IN DETERMINING THE RADON CONTENT OF AIR. Herrmann, D. B.; Zindler, H. (Staatliche Zentrale fuer Strahlenschutz, Berlin). Kernenergie, 11: 203-7(July 1968). (In German).

Direct ionization chamber measurements of radon concentration are compared with indirect ones carried out by collecting the radon daughter products on filters in air of various aerosol contents. The filter measurements are insignificantly dependent on the aerosol concentration and give values of about 2.8 times too low in the mean, for the aerosol concentrations under consideration with present aerosol spectrum. For explaining this fact the problem of preferred attachment of the radon daughter products on aerosol of different diameter is discussed. It was concluded that a considerable fraction of activity is not attached on particles larger than 0.03 μm in diameter. (auth)

48834 DETERMINING THE NATURAL URANIUM IN WATER BY MEASURING THE ALPHA ACTIVITY. Uray, I.; Stoicovici, S. Rev. Chim. (Bucharest), 19: 415-16(July 1968). (In Rumanian).

A method for the determination of uranium in drinking water by measuring absolute α emission in liquid scintillator is described. The efficiency of the method was about 88 ± 3% in 50 μg/l. (tr-auth)

48835 PRESENT STATUS OF ACTIVATION-ANALYSIS APPLICATIONS IN CRIMINALISTICS. Jervis, R. E. (Univ. of Toronto). Isotop. Radiat. Technol., 6: 57-70(Fall 1968).

The application of neutron activation to crime investigation is discussed; the areas covered are: toxicology—detection of arsenic, mercury, and thallium in hair; phosphorus in the liver; selenium in blood; chlorine- and bromine-labeled toxic pesticide residues in grains; and transference of forensic materials—analysis of ballistic residues on skin and clothing and identification of bullet holes; identification of soil transferred from the scene of a crime; activation comparisons of human hair; analyses of fibers and tissues; characterization of drugs; activation matching of physical evidence such as glasses, bullets, and paints. The importance of the technique is evaluated. (65 references). (auth)

48836 DETERMINATION OF LANTHANUM BY FLAME PHOTOMETRIC TITRATION. Svehla, G.; Slevin, P. J. (Queen's Univ., Belfast). Talanta, 15: 978-82(Sept. 1968).

The flame emission of lanthanum at 560 mμ decreases linearly with phosphate concentration until a 1:1 molar ratio is reached, and then remains practically constant. Lanthanum can be titrated with phosphate and the equivalence point detected from the change in emission intensity. Errors due to consumption of solution by the atomizer can be kept low by using short spraying times and low galvanometer damping. The average error is about –1% for 0.1M solutions and less than –5% for 0.01M. The method gives good results in the presence of titanium(III), zirconium, thorium, and aluminum, but cerium(III) and yttrium seriously interfere. (auth) (UK)

48837 IMPROVEMENT OF THE SENSITIVITY OF MOLYBDENUM AND TUNGSTEN DETERMINATION IN NIOBIUM AND TANTALUM. Kallmann, S.; Hobart, E. W.; Oberthin, H. K. (Ledoux and Co., Teaneck, N. J.). Talanta, 15: 982-5(Sept. 1968).

A more sensitive dithiol method is described for determination of as little as 0.5 ppM molybdenum and tungsten in high-purity niobium and tantalum. The increased sensitivity is achieved by taking a much larger sample and extracting the bulk of the Nb or Ta into isobutyl methyl ketone. Selective extraction then separates Mo and W. (auth) (UK)

48838 ANALYSIS OF NIOBIUM ALLOYS. Ferraro, T. A. (Army Materials and Mechanics Research Center, Watertown, Mass.). Talanta, 15: 923-30(Sept. 1968).

An ion-exchange method was applied to the analysis of synthetic

mixtures representing various niobium-base alloys. The alloying elements that were separated and determined included vanadium, zirconium, hafnium, titanium, molybdenum, tungsten, and tantalum. Mixtures containing zirconium or hafnium, tungsten, tantalum, and niobium were separated by means of a single short column. Coupled columns were employed for the resolution of mixtures containing vanadium, zirconium or titanium, molybdenum, tungsten, and niobium. The separation procedures and the methods employed for the determination of the alloying elements in their separate fractions are described. (auth) (UK)

48839 CO-PRECIPITATION TECHNIQUE FOR ALPHA SPECTROSCOPIC DETERMINATION OF URANIUM, THORIUM, AND PLUTONIUM. Lieberman, R.; Moghissi, A. A. (Southeastern Radiological Health Lab., Montgomery, Ala.). Health Phys., 15: 359-62(Oct. 1968).

Use of coprecipitation techniques is described to provide a rapid and routine determination of Th, U, and Pu in environmental samples. The samples investigated included food, vegetation, and soil. The actinides were first separated from each other and from interfering elements by ion exchange methods. Coprecipitants examined included hydroxides, oxalates, and fluorides; of these, hydroxides did not prove satisfactory. Thorium was coprecipitated with lanthanum oxalate with high recoveries. Other coprecipitations studied were: Th and Pu (together) with lanthanum fluoride, and U with lanthanum fluoride. Details of the techniques are given, including the subsequent alpha spectroscopy. It is emphasized that the La used should be of high purity and free of alpha activity. It is stated that the method is simpler and less costly than the electroplating procedure. (UK)

48840 ACTIVATION ANALYSIS FOR SELENIUM AND TELLURIUM TRACE IMPURITIES IN GALLIUM, ARSENIC, AND GALLIUM ARSENIDE. Rausch, H. (Research Inst. for Telecommunication, Budapest); Salamon, A. Talanta, 15: 975-8 (Sept. 1968).

Destructive and nondestructive activation analysis for selenium and tellurium was studied. In destructive analysis the selenium and tellurium activities were coextracted from irradiated and dissolved matrix elements with dithizone/CCl_4 reagent in a hot-chamber by remote manipulation, then separated from each other by diethylammonium-N,N-diethyldithiocarbamate/CCl_4 extraction, tellurium going into the organic phase and selenium being retained by the aqueous phase. The sensitivity of the method is 10^{-8} g for both elements. By nondestructive methods selenium can be determined down to 10^{-6} g on short irradiation, and down to 3×10^{-8} g on long irradiation and cooling, and tellurium down to 10^{-6} g with long irradiation and cooling. (auth) (UK)

48841 RADIOACTIVATION ANALYSIS OF TRACE ELEMENTS IN REFINED SOYBEAN OILS. I. IRON, COBALT, AND NICKEL. Shinbori, Yoshio (Musashi Inst. of Tech., Japan). Yukagaku, 17: 430-5(Aug. 1968). (In Japanese).

Iron, cobalt, and nickel in refined soybean oils were determined by neutron activation analysis followed by radiochemical purification of the resulting radioactive iron, cobalt, and nickel. After neutron irradiation of the oils in a small reactor of TRIGA-II type, followed by chemical separation based mainly on ion exchange of the iron and cobalt, the nickel was separated by Ni-dimethylglyoxime precipitation method. These elements were determined by β-decay and γ-spectrometry. The sensitivity limits were about $\times 10^{-7}$ grams for iron, $\times 10^{-8}$ grams for cobalt and $\times 10^{-9}$ grams for nickel when 1 to 3 grams samples are irradiated for 0.5 to 150 hrs in a thermal neutron flux of about 10^{12} n/cm^2/sec. (auth)

48842 NEUTRON ACTIVATION ANALYSIS OF POTASSIUM IN ULTRABASIC ROCKS. Nagasawa, Hiroshi (Gakushuin Univ., Japan); Wakita, Hiroshi. Geochem. J. (Nagoya), 1: 149-54(Nov. 1967).

A convenient neutron activation method is reported for the determination of potassium contents less than 100 ppM, and also some results on the potassium content of peridotite nodules. It depends on the γ-activity from ^{42}K. Powdered samples and the flux monitor were irradiated with 8×10^{13} n/cm^2/sec for 20 min in a reactor. Other ^{42}K-producing nuclear reactions were too small to interfere with the measurement of ^{42}K from ^{41}K. This indicates that the method is applicable for the determination of potassium in ultrabasic rocks, with total error about 5%. (NSA of Japan)

48843 CONTRIBUTION TO ^{7}Li DETERMINATION BY NUCLEAR RESONANCE. Koch, F.; Niculescu (Babes-Bolyai Univ., Cluj). Isotopenpraxis, 4: 150(Apr. 1968). (In German).

The relative line displacement of the ^{7}Li resonance in aqueous solution of LiCl was measured in solutions to which a paramagnetic ion was added ($CuSO_4$ or $MnSO_4$). The same linear displacement was found with both additions. The displacements obtained are reproducible. A second series of measurements showed the signal amplitude at various ion concentrations of $MnSO_4$. At 0.1 mol/l Mn^{2+} a maximum signal was obtained. (J.S.R.)

48844 PREPARATION OF MICROWAVE-EXCITED ELECTRODELESS DISCHARGE TUBES FOR TITANIUM, VANADIUM, AND ZIRCONIUM FOR USE AS SPECTRAL-LINE SOURCES. Dagnall, R. M.; Pribil, R.; West, T. S. (Imperial Coll. of Science and Tech., London). Analyst, 93: 281-5(May 1968).

The preparation of microwave-excited electrodeless discharge tubes as spectral-line sources for atomic-absorption and atomic-fluorescence spectroscopy of titanium, vanadium, and zirconium is described. A long, cylindrical, resonant cavity was found particularly useful for elements such as these. (auth) (UK)

48845 MICRODETERMINATION OF CHLORINE IN RARE-EARTH-METAL CHLORIDES AND ZIRCONIUM AND HAFNIUM OXYCHLORIDES. Shklover, L. P.; Iovdal'skaya, V. D.; Trushina, T. A. Tr. Vses. Nauch.-Issled. Inst. Khim. Reaktivov, No. 29, 31-3(1966). (In Russian).

The 3 to 8 mg sample is dissolved in 25 ml of H_2O, and the pH of the solution is adjusted to 1.5 to 2 with 0.5 N HNO_3. Ten drops of a 1% ethanolic solution of diphenylcarbazone are added as an indicator, and the solution is titrated with 0.005 N $Hg(NO_3)_2$ to produce a pale lilac color. A blank determination is carried out. The mean square error in the analysis of $ErCl_3 \cdot 6H_2O$ is ±15%. (Anal. Abstr.)

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Refer also to abstracts 48872, 48878, 48880, 49182, 49406, 49987, and 50222.

48846 (ANL-Trans-670) METHOD FOR THE PREPARATION OF NEPTUNIUM IN THE 7-VALENT STATE. Spitsyn, V. I.; Krot, N. N.; Mefod'eva, M. P.; Gel'man, A. D. Translated by Elmar K. Wilip (Argonne National Lab., Ill.), from Dokl. Akad. Nauk SSSR, 181: 128-30(1968). 5p. Dep. CFSTI.

The possibility of obtaining Np^{7+} without using ozone was investigated. Reactions of Np^{6+} with XeO_3 gave Np^{7+} very rapidly, while reactions with perxenonate ions gave Np^{7+} much more slowly. Reactions of neptunates with alkaline solutions of $K_2S_2O_8$ also gave Np^{7+} ions. Perborates could not be used in the preparation of these ions because of the formation of the reducing agent H_2O_2. Reactions with periodates and bismuthates gave Np^{7+} ions as did hypochlorite and hypobromite ions and bromine. (M.C.G.)

48847 (CEA-R-3558) REACTIONS UF_4–ClF, UF–ClF_3, UF_5–ClF, UF_5–ClF_3. Luce, Michel; Benoit, Raymond; Hartmanshenn, Olivier (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). June 1968. 59p. (In French). Dep.

The reaction between ClF_3 and UF_4 is partially explained by the study of the reactions of the three systems: UF_4–ClF, UF_5–ClF, and UF_5–ClF_3. The analytical techniques used were: microsublimation, infrared spectroscopy, and thermogravimetry. The origin of the by-products is indicated. (auth)

48848 (JINR-P7-4021) CHEMICAL STUDIES OF KURCHATOVIUM ELEMENT 104. III. CHEMICAL DEVICE IN THE CYCLOTRON BEAM. Chuburkov, Yu. T.; Zvara, I.; Shilov, B. V. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Reactions). 1968. 30p. (In Russian). Dep.

Design and operation of chemical instruments installed in the intrinsic cyclotron beam for multicharged ions are described. Physico-chemical conditions used in the studies of chemical properties of Kurchatovium (element 104) ($T_{\frac{1}{2}}$ = 0.3 sec) are discussed. (tr-auth)

48849 (KFK-771) THE REACTION RATIO OF URANIUM MONONITRIDE WITH METAL OXIDES. Kleykamp, H.; Korogiannakis, P.; Politis, C.; Thuemmler, F.; Wedemeyer, H. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Material- und Festkoerperforschung). May 1968. 66p. (In German). Dep.

Specimens containing 30 vol % UN and 70 vol % metal oxide were annealed together in high vacuum (at about 10^{-5} torr) at 600 and 1,100°C for 10 and 25 hours, respectively. With few exceptions, the annealing processes were accompanied by reactions resulting in the oxidation of UN to form UO_2 and by a reduction of the metal oxides. The reduction products which could be identified, were free metals, metal nitrides, and in some cases metal oxides with less

oxygen content. U_2N_3 was formed as a by-product in the conversion with MgO and γ-Al_2O_3. While the reactions were low at 600°C, considerable conversions could in most cases be observed for annealings at 1,100°C. The individual reaction products were determined by x rays with goniometer pictures. Because of their high vapor pressures the free metals of the light metals (Mg,Al) could partly be found as distillates in the cooler regions of the reaction tube. Cubic crystals forming silicium could not be determined by x rays, since it has almost the same lattice constant as UO_2. However, in the relevant pictures on the crystal structure a phase can be detected which is attributable to Si. An attempt was made to establish reaction equations for the observed reactions by using the known thermodynamic data. (P.C.H.)

48850 (ORNL–4277) THEORY OF AN INITIAL-BOUNDARY VALUE PROBLEM OCCURRING IN THE STUDY OF FISSION PRODUCT DEPOSITION. Nelson, Paul Jr.; Kress, T. S. (Oak Ridge National Lab., Tenn.). Sept. 1968. Contract W-7405-eng-26. 30p. Dep. CFSTI.

A theoretical study was made of an initial-boundary value problem for a semilinear hyperbolic system of two partial differential equations in two unknowns depending on one spatial variable x and the time t. The nondimensional equations were developed to describe deposition of fission products from a carrier stream onto an isothermal conduit surface with a saturating adsorption-desorption reaction. However they may have general application to convective systems in which a first order chemical reaction at the surface is kinetically important. The following results are obtained: there exists a solution defined and bounded on $0 \leq x \leq 1$ and $0 \leq t < \infty$ and continuously differentiable everywhere except along a characteristic which passes through a discontinuity of the data; the solution described is unique in the class of pairs of bounded measurable functions on $0 \leq x \leq 1$, $0 \leq t < \infty$; and the solution tends pointwise to one of the solutions of the steady-state equations obtained by ignoring time derivatives in the original problem. In addition a certain recursively defined sequence of function pairs is shown to converge to the solution and to alternately bound it above and below. (auth)

48851 (ORNL–4307) ONEPHASE: A SIMPLIFIED FORTRAN 63 PROGRAM FOR COMPUTING TABLES OF THERMODYNAMIC DATA FOR COMPOUNDS IN ONE PHASE. Fontana, M. H. (Oak Ridge National Lab., Tenn.). Sept. 1968. Contract W-7405-eng-26. 17p. Dep. CFSTI.

A simplified Fortran program was written to compute thermodynamic properties using specific heat equations, and the entropy and the heat of formation at some known temperature. The program computes and prints tables of the following properties: specific heat, enthalpy, entropy, heat of formation, free energy of formation, and the equilibrium constant of formation. Cards may be punched directly for use by computer programs requiring data input in this format. (auth)

48852 (SWRHL–8-r) METHOD FOR POSITIVE COLLECTION OF IODINE FROM AIRBORNE CARBON–IODINE BONDED COMPOUNDS. Whittaker, E. L.; Bretthauer, E. W.; Griffin, R. J.; Worford, T. F.; Rawson, R. D. (Public Health Service, Las Vegas, Nev. Southwestern Radiological Health Lab.). June 26, 1964. 10p. Dep. CFSTI.

A method for quantitative collection of iodine from carbon–iodine bonded compounds is described. This method utilizes a high frequency electric spark to rupture the carbon–iodine bond followed by collection of the resultant ionic and molecular iodine forms on ion-exchange resin. (auth)

48853 (RT/CHI–(68)18) A STUDY ON TWO METHODS SUITABLE FOR THE INVESTIGATION OF THE INTERACTIONS BETWEEN SOME VOLATILE FISSION PRODUCTS AND THE SURFACE OF URANIUM DIOXIDE. Nagy, L. G.; Cesarano, C.; Segre, G. J. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). 1968. 50p. Dep.

Studies were made on physico-chemical methods that are suitable for investigating the surface properties of UO_2 and the reactions between some fission products and UO_2. The first method described uses measurements of the heat of immersion for the study of surface properties of UO_2. This method is useful for studying changes in surface properties after irradiation. The second method uses heterogeneous isotopic exchange to investigate the chemical form of some fission products, the surface properties of UO_2, and its specific surface. A study is also reported on the nature of chemical forces at the solid-gas interface in order to understand the results of experiments carried out by the methods described. (P.C.H.)

48854 COMPOUNDS OF SCHIFF'S BASES WITH URANIUM (IV), ZIRCONIUM(IV), AND THORIUM(IV). Poddar, Sailendra Nath; Biswas, Dilip K. (Indian Association for the Cultivation of Science, Calcutta). Sci. Cult. (Calcutta), 34: 117-18(Mar. 1968).

The preparation and properties of complexes of U(IV), Th(IV), and Zr(IV) with Schiff's base are described. (M.C.G.)

48855 MASS PRODUCTION AND PRACTICAL APPLICATIONS OF ACTINIDE ELEMENTS. Seaborg, Glenn T. (Atomic Energy Commission, Washington, D. C.). Isotop. Radiat. Technol., 6: 1-18(Fall 1968).

Some possibilities in the production and use of transuranium elements are described and forecast. The actinides as energy sources, radiation application, reactor fuels beyond ^{239}Pu, actinides for the chemist, large-scale production of the actinides, the High Flux Isotope Reactor, the resonance reactor concept, underground nuclear explosions for the production of isotopes, the accelerator as a neutron source, and actinides in the future are discussed. (46 references). (M.C.G.)

48856 ISOTOPE EXCHANGE RATES. VI. THE HOMOGENEOUS SELF-EXCHANGE IN HYDROGEN DEUTERIDE. Lewis, David; Bauer, S. H. (Cornell Univ., Ithaca, N. Y.). J. Amer. Chem. Soc., 90: 5390-6(Sept. 25, 1968).

The isotopic exchange reaction $2HD \rightarrow H_2 + D_2$ was studied in a single-pulse shock tube over the temperature range 1120 to 1659°K. Sample mixtures consisted of 1.0 to 4.5% HD in argon. The total density behind the reflected shocks ranged from 1×10^{-2} to 7×10^{-2} mol/l. High-temperature residence times were about 1 msec. The deduced power rate expression is 1.43 ± 0.1 order in HD and 0.57 ± 0.1 order in argon. The second-order rate constant for the reaction is $k_s = 2.45 \times 10^9 \exp[(-35{,}940 \pm 2000)/RT]$ l. $mole^{-1}$ sec^{-1}. These data support a mechanism similar to that proposed for other exchange reactions [$D_2 + H_2$, H_2S, H_3N, H_4C]. In this model, the probability for exchange during a collision of two HD molecules is greatly enhanced when one of them is excited to or above a critical vibrational level so that the over-all exchange rate is limited by the rate of repopulating that level (the third for HD). The ratios of the relative excitation efficiencies of HD–HD and HD–Ar collisions and the relative probabilities for exchange in HD*–HD collisions vs. deexcitation via HD*–Ar collisions were determined from the rates measured in these experiments. Also, an over-all constant for vibrational excitation of HD by argon was obtained. These kinetic parameters are entirely compatible with related parameters previously reported for the reverse of this exchange reaction, $H_2 + D_2 \rightarrow 2HD$, and with data obtained from direct measurement of vibrational relaxation times. (auth)

48857 REACTIONS OF 8-QUINOLINOL WITH COVALENT HALIDES. PART III. ZIRCONIUM, TETRAFLUORIDE, AND ZIRCONIUM, HAFNIUM, AND THORIUM TETRACHLORIDES. Frazer, M. J.; Rimmer, B. (Northern Polytechnic, London). J. Chem. Soc., A, No. 9, 2273-5(1968).

Reaction, at 20°C, of 8-quinolinol (oxH) (1 or 2 mol) with zirconium tetrafluoride (1 mol) gave only the adduct ZrF_4, oxH; but with zirconium and hafnium tetrachlorides (MCl_4) (1 mol) the adducts MCl_4, 2oxH were obtained. At 65°C or in a sealed tube, MCl_4 (1 mol) and 8-quinolinol (8 mol) gave the chelate compounds M ox_4. Precipitates of overall composition $ThCl_4$, noxH (n = 2, 3, 4, or 6) were formed in the reactions with thorium tetrachloride. The precipitate with n = 6 consists of 8-quinolinolium chloride (3 mol) and the seven-co-ordinate thorium compound, ThCl ox_3. This compound was also formed from Th ox_4 and thorium tetrachloride. (auth) (UK)

48858 COPRECIPITATION OF Cr(VI), W(VI), AND U(VI) TRACERS WITH LEAD MOLYBDATE AND MOLYBDENUM 8-HYDROXY QUINOLATE. Qaim, S. M.; Karim, H. M. A. (Atomic Energy Centre, Labore, Pakistan). J. Inorg. Nucl. Chem., 30: 2279-82(Sept. 1968).

Two commonly used precipitating reagents for Cr, Mo, W and U are lead acetate and 8-hydroxyquinoline. A study is described for the coprecipitation behavior of tracer Cr, W, and U when Mo(VI) is precipitated using these two reagents. (auth) (UK)

48859 URANYL TROPOLONATE COMPLEXES. Plymale, T. L.; Smith, W. H. (Monsanto Research Corp., Miamisburg, Ohio). J. Inorg. Nucl. Chem., 30: 2267-9(Sept. 1968).

The ability of tropolone, (2-hydroxy-2,4,6 cycloheptatrien-1-one), to form very stable complexes with the uranyl ion is well known. Investigations were carried out in order to isolate and characterize these uranyl tropolonates. Previous studies have established that uranyl ion combines with tropolone in the ratios of 1:1, 1:2 and 1:3. The isolation of only the 1:2 and 1:3 complexes in the solid state was accomplished. (auth) (UK)

48860 CRYSTAL DATA FOR $UO_2(OAc)_2 \cdot 2Ph_3AsO$ AND $[UO_2(OAc)_2 \cdot Ph_3AsO]_2$. Bandoli, Giuliano; Graziani, Rodolfo; Zarli, Bruno (CNR, Padua). Acta Crystallogr., Sect. B, 24: 1129-30(1968).

Crystal data are reported for $UO_2(OAc)_2 \cdot 2Ph_3AsO$ and $[UO_2(OAc)_2 \cdot Ph_3AsO]_2$, which are crystallographically isomorphous with their respective triphenylphosphine analogues. (auth)

48861 CRYSTALLIZATION CHARACTERISTICS OF ACIDIC URANYL NITRATE SOLUTIONS. Kispert, R. C.; Cavendish, J. H.; Leist, N. R.; Miller, G. P. (National Lead Co. of Ohio, Cincinnati). Nucl. Appl., 5: 224-7(1968).

Crystallization temperatures of impure acidic uranyl nitrate solutions were correlated with the total and free nitrate concentrations. This correlation may be used to predict the solution stability under the varying ambient conditions encountered during transportation and storage and should promote nuclear safety in the handling of uranyl nitrate solutions enriched in ^{235}U. (auth)

48862 TRANSURANIUM ELEMENTS. Mueller, Werner. Atomes (Paris), 23: 21-7(Jan. 1968). (In French).

The chemistry and methods of preparation of the transuranium elements are reviewed; oxidation states are compared with those of the actinides. Routes for production of elements from U or the first few transuranium elements are divided into 3 categories: neutron bombardment by a neutron flux; bombardment from a nuclear explosion; and bombardment by charged particles exiting from an accelerator. The first is the only important method for production of substantial quantities. The last has been used for the production of Lw, whose synthesis is described, and of element one hundred and four. Extension of the principles of ion bombardment to the use of actinide nuclei themselves for the production of very heavy nuclei is elaborated. Processes in use for the production of Pu, Am, and Cm at Savannah River and Oak Ridge are sketched. Uses for the transuranium elements are outlined: Pu is used in reactors, and some α emitters can be used as sources of heat, particularly ^{238}Pu, ^{242}Cm, and ^{244}Cm. The application of ^{252}Cf as a source of high neutron flux is noted. (BBB)

48863 NEUTRON DIFFRACTION STUDY OF ICE POLYMORPHS. I. ICE IX. Rabideau, S. W.; Finch, E. D.; Arnold, G. P.; Bowman, A. L. (Los Alamos Scientific Lab., N. Mex.). J. Chem. Phys., 49: 2514-19(Sept. 15, 1968).

The neutron diffraction spectrum of polycrystalline D_2O ice IX (the form recovered at liquid-nitrogen temperature at atmospheric pressure) was obtained and it is in agreement with a proton-ordered structure for this ice. Values of the tetragonal, pseudocubic lattice parameters were found to be $a_0 \simeq c_0 = 6.745 \pm 0.004$ Å at 80°K. A computer-generated least-squares fitting of the intensities of the 38 observed reflections gave the scale factor, thermal parameter, and the oxygen and deuteron position parameters. The O–O–O bond angles are appreciably distorted from the tetrahedral angle in this high-pressure polymorph. (auth)

48864 RAMAN SPECTRA OF POLYCRYSTALLINE H_2S AND D_2S. Miller, R. E.; Leroi, G. E. (Princeton Univ., N. J.). J. Chem. Phys., 49: 2789-97(Sept. 15, 1968).

The Raman spectra of H_2S and D_2S were obtained in all three solid modifications, using both conventional and laser excitation. The spectra in the two higher-temperature phases are consistent with their known disordered crystal structures. Previously undetected vibrational structure also was obtained for both the internal and lattice vibrations in the lowest-temperature phase (III); an assignment of the entire spectrum is proposed. Conclusions about the crystal structure of this phase, which was not previously established, can be drawn from the combined results of x-ray, electron diffraction, infrared, far-infrared, and Raman investigations. It is shown that a C_{4h} structure with eight molecules per unit cell on C_1 sites fits all the data for Phase III of H_2S and D_2S. (auth)

48865 ION EXCHANGE CHROMATOGRAPHY OF RARE EARTHS IN AQUEOUS ORGANIC MEDIA. VI. STABILITY CONSTANTS OF TERBIUM WITH α-HYDROXYISOBUTYRIC ACID IN THE SYSTEM METHANOL–WATER. Alexa, J. (Inst. of Nuclear Research, Prague). Collect. Czech. Chem. Commun., 33: 2731-7(Aug. 1968).

The stability constants of terbium complexes with 2-methyllactic acid were determined in methanol–water mixtures. The results were used to compute the separation factor for the Eu–Tb system. (P.C.H.)

48866 BREAKDOWN OF THE URANYL GROUP IN STRONGLY ACID SOLUTIONS. Nemodruk, A. A.; Palei, P. N.; Glukhova, L. P.; Karyakin, A. V.; Muradova, G. A. (Inst. of Geochemistry and Analytical Chemistry, Moscow). Dokl. Akad. Nauk SSSR, 180: 872-5(June 1, 1968). (In Russian).

Under certain conditions hexavalent uranium may be present in its less hydrolyzed form as UO^{4+}. If the H ion concentration is increased in the solution, the reaction may go in the direction opposite to hydrolysis: $UO_2^{2+} + 2H^+ \rightleftharpoons UO^{4+} + H_2O$. Such a reaction may take place between U(VI) with the reagent arsenazo III, yielding the highest absorption of the complex in the 656 to 665 mμ range at a pH of 2 to 3. It has been assumed that the uranyl ion forms the tetravalent UO^{4+} ion, which then reacts with arsenazo as other tetravalent cations. This reaction makes it possible to verify the breakdown of uranyl ion in strongly acid solutions by observing the disappearance or the reduction of the intensity of the infrared absorption band. Similar experiments were carried out in the UV spectrum. From the optical density data the equilibrium constant K of the above reaction could be determined. The value of $K = 6.4 \times 10^{-5}$, determined by spectrophotometric data agrees with the value derived from infrared absorbed intensity data. This confirms that the breakdown of the uranyl group follows the above reaction. (TTT)

48867 PHOSPHONAZO III AND TWO OF ITS ANALOGUES. Lukin, A. M.; Bolotina, N. A.; Chernysheva, T. V.; Zavarikhina, G. B. Tr. Vses. Nauch.-Issled. Inst. Khim. Reaktivov, No. 30, 42-9(1967). (In Russian).

The reagent phosphonazo III [4,5-dihydroxy-3,6-bis[(o-phosphonophenyl)azo]-2,7-naphthalenedisulfonic acid] (I) has been synthesized and its properties and reactions with metal cations have been studied. The absorption maximum of solution of I is at 555 nm. The color of solution of I at different acidities differs from that of arsenazo III and chlorphosphonazo III. I gives reactions of the greatest contrast with Th, U(VI), Hf, Zr, La, Sc, Ti, Ca, Ba, and Sr, of absorption maxima at 680, 670, —, 680, 670, 665, 660, 645, 635, and 640 nm, respectively. The main advantage of the phosphono-analogues over arsenazo III is the possibility of determining elements in the presence of large amounts of PO_4^{3-}, F^-, EDTA, and other masking agents. (Referat. Zh.)

48868 THE SOLUTION ABSORPTION SPECTRUM OF Bk^{3+} AND THE CRYSTALLOGRAPHY OF BERKELIUM DIOXIDE, SESQUIOXIDE, TRICHLORIDE, OXYCHLORIDE, AND TRIFLUORIDE. Peterson, Joseph Richard. Berkeley, Calif., Univ. of California, 1967. 107p.

Thesis.

A systematic study of the physical and chemical properties of berkelium and its compounds was begun. A total of ~30 μg ^{249}Bk was made available for use in the study. The procedures used to purify the ^{249}Bk solution are discussed in detail, as are the analytical techniques used to evaluate the purity of the Bk sample following each purification cycle. Repeated purifications were necessary to maintain the Bk samples in a state of high purity, since ^{249}Bk decays to ^{249}Cf at the rate of ~0.2% per day. The experimental techniques used to study the Bk^{3+} solution absorption spectrum are discussed. One of these techniques, using a newly developed, light-pipe, microabsorption cell, marks a significant advancement in the further development of experimental techniques suitable for heavy-actinide-element research. The composite results of the observed spectra yielded 16 Bk^{3+} absorption peaks in the wavelength region 320 to 700 mμ. The two most intense peaks observed were at 418 and 474 mμ. The experimentally determined, electronic energy levels of Bk^{3+} were compared with theoretically derived values; however, no attempt to fit the observed data to the theoretical energy level scheme was made. Mention is made of an unsuccessful attempt to observe the Bk^{4+} solution absorption spectrum. A discussion of the techniques to prepare a series of compounds on a single, submicrogram sample of material is given. These techniques were employed to prepare five compounds of berkelium. The conditions used to prepare these five Bk compounds are given, along with a discussion of the treatment of the data obtained from x-ray examination of the compound samples. All samples of BkO_2 exhibited the fluorite-type, face-centered cubic structure with the purest sample yielding a lattice parameter $a_o = 5.334 \pm 0.001$ A. The dioxide stoichiometry was assumed, as was that of the Mn_2O_3-type cubic sesquioxide. The purest sample of Bk_2O_3 yielded a cubic lattice parameter $a_o = 10.889 \pm 0.003$ A. The effect of time on both of these lattice parameters was noted. These lattice parameter error limits represent the 95% confidence interval reflecting only the internal consistency of the data for these particular preparations. The structure exhibited by $BkCl_3$ samples was the UCl_3-type hexagonal structure having lattice parameters $a_o = 7.382 \pm 0.002$ A and $c_o = 4.127 \pm 0.003$ A. Samples of BkOCl exhibited the PbFCl-type tetragonal structure having lattice parameters $a_o = 3.966 \pm 0.004$ A and $c_o = 6.710 \pm 0.009$ A. The lattice parameter error limits reported for $BkCl_3$ and BkOCl are the 95% confidence interval calculated using the standard statistical method for the average of three independent determinations. BkF_3 samples exhibited two crystal structures, a low-temperature, YF_3-type orthorhombic structure and a high-temperature, LaF_3-type trigonal structure. Best estimates for the lattice parameters of these two BkF_3 modifications are: $a_o = 6.70 \pm 0.01$ A, $b_o = 7.09 \pm 0.01$ A, $c_o = 4.41 \pm 0.01$ A (ortho-

rhombic) and $a_o = 6.97 \pm 0.01$ A, $c_o = 7.14 \pm 0.01$ A (trigonal). The lattice parameter error limits reported are empirical, reflecting the uncertainties in the derivation of the lattice parameters. Comparisons of the lattice parameters of these berkelium compounds with those of similar actinide compounds consistently showed evidence of the actinide contraction. Calculations of the Bk^{3+} radius from the crystallographic data of Bk_2O_3, $BkCl_3$, and BkF_3 are tabulated. With reference to these calculations the limitations of the concept of ionic radius are discussed. (Disser. Abstr.)

48869 A NUCLEAR MAGNETIC RESONANCE STUDY OF $NH_4H_2PO_4$. Soest, Jon Fredrick. Seattle, Univ. of Washington, 1967. 159p.

Thesis.

An extensive survey of the properties of nuclear magnetic resonance in ordinary and deuterated $NH_4H_2PO_4$ has been made. Observations were made of line width and shape, quadrupole splittings, and spin-lattice relaxation at temperatures above and below the antiferroelectric transition. In the ordinary crystal, unusual proton line width and shape characteristics are attributed to ammonium proton dipolar fields of large magnitude which conceal any effects of the antiferroelectric transition. Changes in line width and shape are shown to be entirely a result of the ammonium rotation. Proton T_1 is also dominated by the rotation, and results of such measurements reflect only the dynamics of the ammonium group. Similarly, observations in the deuterated crystal show the effect of ammonium rotation, particularly in the large relaxation rate and narrowly averaged quadrupole splittings of the ammonium deuterons. In this case, however, the electric quadrupole interaction separates the hydrogen bond (O-D . . O) deuterons from the ammonium (ND_4) deuterons, except at certain crystal orientations in the applied magnetic field where the quadrupole splittings are the same (cross-over). Near cross-over, dipolar coupling with the rapidly relaxed ammonium deuterons leads to a large relaxation rate for the hydrogen bond deuterons. The correlation time relevant to this cross-over relaxation corresponds well with the measured T_1 of ammonium deuterons. At orientations away from cross-over, contributions to the hydrogen bond deuteron relaxation from deuteron jumping between and within hydrogen bonds become observable. Temperature, field, and orientation dependence studies allow the separation of the various contributions. The jump time T_{xy} between bonds is 0.5 sec at 300°K, with a jump activation energy of 0.65 eV — in agreement with conductivity studies. The activation energy for jumps along the bond is estimated to be 0.093 eV. At the antiferroelectric transition, the sudden halt of the jumps along the bond results in an extra splitting of the quadrupole spectrum which was effectively averaged by a jump time $T_j < 10^{-5}$ sec above the transition temperature. Careful analysis of the spectra yields, for the first time, direct evidence of the ordering of deuterons within hydrogen bonds, which is responsible for triggering the antiferroelectric structure. (Diss. Abstr.)

48870 INFRARED AND RAMAN SPECTRA OF ISOBUTENE AND ISOBUTENE-d_9. Pathak, Chandra Mani. Knoxville, Tenn., Univ. of Tennessee, 1967. 138p.

Thesis.

The infrared and Raman spectra of isobutene have been reexamined using Perkin Elmer Model 521 and 225 infrared spectrometers, and a Cary 81 Raman spectrometer. Isobutene-d_9 was synthesized for the first time by the dehydration of perdeuterotertiary butyl alcohol, using $KDSO_4$ as the dehydrating agent. The moments of inertia have been calculated and it was found that, like isobutene, isobutene-d_9 is very nearly a symmetric top. The axis of unique moment of inertia does not coincide with the figure axis in either isotope, and the observed infrared band contours conform very well to the predicted features. On the basis of the infrared and Raman data it was possible to assign all the observed bands of both the isotopes, and most of the assignments agree with those made by others. However, it is felt that some of the assignments made by the others are still incorrect. The high resolving power of the infrared spectrometers used clearly indicated the presence of two additional bands in isobutene, namely the band at 2940.8 cm^{-1} and at 1079.0 cm^{-1}, which have been assigned to ν_1 and ν_{21} respectively. The observation of the band contours have shown conclusively that the infrared frequency at 429.1 cm^{-1} in isobutene, and the one at 363.2 cm^{-1} in isobutene-d_9 are due to the skeletal wagging mode, ν_{29}, in the respective molecules. Using the observed fundamental frequencies of isobutene and isobutene-d_9, force-field calculations have been made with symmetrized force constants, and the results of the calculations have supported the assignments. These calculations have also provided reasons for correction of a few assignments. Thus the infrared band observed at 973.7 cm^{-1} in isobutene has been assigned to the CH_2 rock. It is felt that the CH_2 torsional mode has been incorrectly assigned by others. Two force-fields have been determined using an iterative technique. Using the values of the symmetry force constants from the "reduced-field," it was possible to calculate the magnitudes of the unsymmetrized valence constants (elements of the F matrix of isobutene), and the results obtained are in good agreement with those obtained in other similar molecules. The 28 principal constant force-field has been used to predict the frequencies of two more isotopic species of isobutene, namely, $CH_2 : C(CD_3)_2$ and $CD_2 : (CH_3)_2$. These species have not been synthesized yet, but actual frequencies in these isotopic species should be close to the predicted values. (TSS) (Diss. Abstr.)

Radiation and Nuclear Chemistry

Refer also to abstracts 48855, 48895, 49202, and 49222.

48871 (AERE-R-5790) THE PRODUCTION OF ^{236}Pu AND ^{235}Np IN THE HARWELL VARIABLE ENERGY CYCLOTRON. Jenkins, I. L.; Wain, A. G. (Atomic Energy Research Establishment, Harwell (England)). July 1968. 5p. Dep. CFSTI. UK 1s. 9d.

The production of ^{236}Pu and ^{235}Np in the Harwell Variable Energy Cyclotron is described. Yields of approximately 60 μCi of ^{236}Pu and 72 μCi of ^{235}Np were obtained by irradiating natural uranium with 50-MeV protons. Processing the target by dissolution in nitric acid, followed by precipitation, ion exchange, and amine extraction gave products of good radioactive purity. (auth) (UK)

48872 (CALT-532-37) STUDIES IN CHEMICAL DYNAMICS AND RADIATION CHEMISTRY. Technical Progress Report, July 1, 1967–June 30, 1968. Kuppermann, Aron (California Inst. of Tech., Pasadena). Sept. 6, 1968. Contract AT(04-3)-532. 54p. Dep. CFSTI.

Research progress is reported on diffusion kinetics, low-energy electron scattering, photoelectron spectrometry, elementary reactions by photolysis at variable wavelength, reactions in crossed molecular beams, and theory of chemical reactions. (M.C.G.)

48873 (CONF-660553-7) IRRADIATION OF TERPHENYLS BY FAST ELECTRONS: KINETICS OF DECOMPOSITION OF OM-2 MIXTURES AND EFFECT OF ADDITION OF HB-40. Barrera Pinero, R.; Manero Rodriguez (Junta de Energia Nuclear, Madrid (Spain)). [nd]. 31p. (In Spanish). Dep.

From Panel on Use of Organic Liquids as Reactor Coolants and Moderators, Vienna, Austria.

The radiolytic stability of the commercial mixture of terphenyls Progil-0M2 at temperatures between 150 and 350°C and of various mixtures of 0M2 with HB-40 (Monsanto) at 200°C was studied with static methods under electron irradiation at 1 MeV. The radiolytic effect as a function of the dose controls the disappearance of the initial material, the evolution of gases, and the formation of polymers. The results with respect to 0M2 indicate that the decomposition/dose curves are adapted preferentially to a fractional kinetic order, about 1.5. The kinetics of the process are discussed and a quasi-chain reaction mechanism is followed in which the length of the chain begins to be probably appreciable at temperatures above 400°C. With respect to the effect of temperature on the G(-terph.) and G(-polym.) values, it was proven that the Arrhenius law is followed within the experimental error with the activation energies of 1.4 and 0.54 kcal/mole, respectively. In contrast deviations from this law were found for G(gas). With respect to the effects of the addition of partially hydrogenated terphenyls (HB-40) on the stability of 0M2, it was observed that if the values of G(gas) increase always with the total percentage of hydrogenation, the values of G(-polym.) decrease for hydrogenations below 15%, with a minimum at about 10%. (tr-auth)

48874 (COO-1713-5) REACTION STUDIES OF HOT SILICON RADICALS. Progress Report. Gaspar, Peter Paul (Washington Univ., St. Louis, Mo.). Aug. 30, 1968. Contract AT(11-1)-1713. 4p. Dep. CFSTI.

Studies were made on the mechanism of reactions of silicon atoms recoiling from the nuclear transformation $^{31}P(n,p)^{31}Si$ with phosphine in mixtures with butadiene, silane, and ethylene. Measurements of the absolute yields of the two volatile radioactive products ($^{31}SiH_4$ and $H_3{}^{31}SiSiH_3$) from phosphine–silane mixtures indicate that the product yields increase linearly with the concentration of nonradioactive silane. Ethylene was found to compete with silane for a common reactive intermediate. The reactions of recoiling silicon atoms with phosphine–butadiene mixtures have been found to produce several products which appear to contain a PH_2-group. Slow neutron irradiation of ^{30}Si was also used to produce ^{31}Si. The product spectrum from the reactor-neutron irradiation of silane differed from that obtained from the fast-neutron irradiation of phosphine–silane mixtures. Experiments have also been carried out on the chemistry of recoiling Ge atoms.

The reactions of Ge atoms with germane produce $^{75}GeH_4$ and $H_3{}^{75}GeGeH_3$, quite analogous to the reactions of silicon atoms with silane. (P.C.H.)

48875 (INS-R-58) PRELIMINARY EXPERIMENTS IN POLYMER GRAFTING TO WOOL. McNaughton, G. S.; Prieditis, L. J. (Institute of Nuclear Sciences, Lower Hutt (New Zealand)). June 1968. 25p. Dep.

Preliminary studies on the radioinduced grafting of acrylonitrile to New Zealand crossbred 40/44's and 48's wool using the pre-irradiation technique have been made with ^{60}Co gamma rays. The dilatometric technique for measuring polymerization rates continuously has been investigated but was unsatisfactory since shrinkage factors higher than expected were obtained. Grafting was not very reproducible, possibly because pre-treatment drying conditions are more critical than was realized. The ratio of grafted polymer to total polymer formed was 50 to 70% in pure acrylonitrile. About 20 to 35% increases in wool weight were obtained with 3 Mrad doses in pure acrylonitrile, but the weight increases even on unirradiated wool occasionally were as high as 18% although most values were about 5%. Experiments were also carried out on reduced and thiocarbamylated wools. In other experiments water, formic acid, and allyl methacrylate were each added separately to the acrylonitrile but in no case was any marked increase in the weight of grafted polymer found. (auth)

48876 (JAERI-1155) A STUDY ON RADIATION CATALYTIC CHEMISTRY: IRRADIATION EFFECT ON ACTIVE CARBON CATALYSTS. Sato, Shoichi (Japan Atomic Energy Research Inst., Takasaki. Takasaki Radiation Chemistry Research Establishment). Dec. 1967. 35p. Dep.

The application of radiation energy has been developed gradually in many fields. In order to use the energy of radiation more efficiently, the need has arisen for further study of the catalytic processes. Studies were made on the effects of radiation on materials, especially solids, and also on the effects of radiation in phenomena relating to catalysis. Kinetic studies of catalytic phosgene synthesis over active carbons and of the effects of gamma radiation on the kinetic constants are described. The compensation effect in kinetic factors appeared on irradiation and a marked change in catalytic activity was observed with the dose of 10^8 R. The catalysts were examined by elementary analysis, ESR absorption and ir spectroscopy, and the results are considered on the basis of the catalytic effects. The catalytic sites are reasonably related to the 2-dimensional structure of carbons, and carbons with highly-grown network structure are thought to have high sensitivity to radiation. (auth)

48877 (JINR-P13-3943) EFFECTS OF RADIATION ON THE SEPARATION OF BINARY LIQUID SOLUTIONS. Lytkin, L. K.; Pisarev, A. F.; Sumbaev, A. P.; Chalkin, S. F. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems). 1968. 9p. (In Russian). Dep.

The effects of γ radiation on the separation rate of nitrobenzene solution in hexane at a mole concentration of 0.2 and 0.3 and aqueous triethylamine at a concentration of 0.4, which are supersaturated, was studied. The supersaturation was attained by the impulse changing the pressure over the solution, by fast heating, and by applying an electric field. It was determined that γ radiation speeds up the process of solution separation. (auth)

48878 (NYO-3242-29) THE ACTION OF RADIATIONS ON SOME BIOLOGICAL MODEL SYSTEMS. Technical Progress Report, August 1, 1967-August 15, 1968. Stein, Gabriel (Hebrew Univ., Jerusalem (Israel). Dept. of Physical Chemistry). Contract AT(30-1)-3242. 30p. Dep. CFSTI.

Excitation processes in irradiated systems under the influence of ionizing radiations were investigated. Excitation processes in aromatic systems were examined by studying the temperature dependence of γ-radioinduced trans→cis isomerization of stilbene in toluene. Excitation processes in x-irradiated aqueous solution of sodium salicylate were also studied. The role of free radical processes in the action of ionizing radiation on aqueous solutions of biochemical and biological systems was also investigated. A functional correlation between aromatic and divalent sulfur amino acids in ribonuclease was found in reactions with hydrogen atoms in aqueous solutions. (J.G.B.)

48879 (ORO-2418-5) INFRARED SPECTRA OF PLASTICS AND ELASTOMERS AFTER NUCLEAR IRRADIATION. Annual Progress Report. Sears, W. C. (Georgia Univ., Athens. Dept. of Physics). Sept. 18, 1968. Contract AT(40-1)-2418. 11p. Dep. CFSTI.

Changes in molecular structure produced by high-energy radiation were investigated for different organic polymers. Changes in saturation, polymer crystallinity, crosslinking, and scission were determined by infrared spectroscopy. Some results for butadiene polymers are given. (M.C.G.)

48880 ELECTRON SPIN RESONANCE SPECTRA OF CHEMICALLY MODIFIED LYSOZYME IRRADIATED IN THE SOLID STATE. Blasi, F.; De Masi, V. R.; Soria, M. (Univ., Naples). Biophysik, 3: 335-8(1967).

A study was made on the role of protein structure and particularly of disulfide bonds in the migration and trapping of the radical state. ESR spectra of irradiated native lysozyme, carboxymethyl lysozyme, lysozyme treated with 5% mercuric acetate in 50% acetic acid, trichloroacetic acid precipitated native lysozyme, and lysozyme treated with 6M guanidine were compared. The migration and trapping of free radicals in proteins appear to require either specific interactions or characteristic structures which are provided by the native state of the protein. (J.G.B.)

48881 EFFECT OF γ-RADIATION ON THE AQUEOUS SOLUTIONS OF L-PROLINE AND HYDROXY-L-PROLINE. Korgaonkar, K. S.; Marathe, Savita V.; Chaubal, K. A. (Tata Memorial Centre, Bombay). Sci. Cult. (Calcutta), 34: 100-3(Mar. 1968).

Solutions of L-proline and hydroxy-L-proline were made 0.01M in triple distilled water and irradiated with gamma rays at 1.15×10^5 Rads/hr. Paper chromatography, fluorescence spectra, and ultraviolet absorption were used to study the results. Marked and varied structural changes were observed. (M.C.G.)

48882 ELECTRONS IN AQUEOUS AND ORGANIC MEDIA AND A MODEL FOR RADIOLYSIS. Hamill, William H. (Univ. of Notre Dame, Ind.). J. Chem. Phys., 49: 2446-7(Sept. 1, 1968).

Reactions of nonhydrated radiolytic electrons and holes in irradiated water and solutions were studied. (M.C.G.)

48883 RADIATION CHEMISTRY. Dorfman, Leon M.; Firestone, Richard F. (Ohio State Univ., Columbus). Annu. Rev. Phys. Chem., 18: 177-204(1967).

A review is presented on radiation chemistry with special attention given to primary and secondary reactive species. The subject matter is grouped partly under the types of reactive species as well as under the general types of systems. This includes: aqueous solutions; solvated electron in nonaqueous media; organic liquids; gas-phase radiolysis; dosimetry and energy partition in irradiated gases; and ion-molecule reactions in the gas phase. (P.C.H.)

48884 ELECTRON SPIN RESONANCE STUDY OF SOME X-IRRADIATED AMIDE SINGLE CRYSTALS. Hamrick, Phillip J. Jr.; Shields, Howard W.; Parkey, Sara H. (Wake Forest Univ., Winston-Salem, N. C.). J. Amer. Chem. Soc., 90: 5371-5 (Sept. 25, 1968).

Free radicals of the type R_2CCONH_2 were identified by their ESR spectra in x-irradiated single crystals of propionamide, n-butyramide, and isobutyramide. Spectra were recorded and analyzed for a number of orientations of the crystals in the magnetic field. Principal values of the hyperfine coupling constants and their direction cosines with respect to the reference axes are given. The g values are nearly isotropic and the values measured along each of the reference axes are given. In certain orientations hyperfine splitting due to the ^{14}N and ^1H nuclei of the amino group was resolved. An approximate ^{14}N coupling tensor was derived for the radical in isobutyramide. (auth)

48885 NUCLEAR MAGNETIC RESONANCE IN IRRADIATED POLYMERS. Chierico, Angelo; del Nero, Gianni; Lanzi, Giuseppe (Univ., Pavia, Italy). pp 801-22 of Fisica del Reattore. Rome, Consiglio Nazionale delle Ricerche, 1966. (In Italian).

From Conference on Physics of Reactors, Milan. See CONF-469.

The chemical structure, physical properties, intramolecular forces, and molecular constituents of polymers are summarized. Radiation effects on polymers are discussed. The fundamental principles of nuclear magnetic resonance are considered; application to studies of irradiated polymers is described. Experiments using polyethylene are described; data are shown graphically. (23 references.) (M.L.S.)

48886 IONIC CHAIN REACTIONS IN THE RADIATION-SENSITIZED PYROLYSIS OF ETHANOL VAPOR. Bansal, K. M.; Freeman, G. R. (Univ. of Alberta, Edmonton). J. Amer. Chem. Soc., 90: 5632-3(Sept. 25, 1968).

Two new types of ionic chain reactions occurring during the γ-sensitized pyrolysis of ethanol vapor at 350°C are reported. One chain resulted in the conversion of ethanol to diethyl ether and water, while the other formed methanol and acetaldehyde from formaldehyde and ethanol. The G values of diethyl ether in ethanol irradiated at a density of 0.66 g/l are 1.1 (320°C); 5.6 (350°C); and 15.9 (375°C). A mechanism for ether formation is proposed. During the radiolysis of ethanol vapor, methanol was formed with G values of 50. In order to determine the mechanics of the reaction a sample containing 5 mole% of formaldehyde was irradiated. The

increase in the G values of methanol and acetaldehyde were 563 and 521, respectively, and corresponded to the conversion of 70% of the formaldehyde in the sample. (D.H.M.)

48887 RADIATION-INDUCED SOLID-STATE POLYMERIZATION. O'Donnell, J. H. (Univ. of Queensland, Brisbane). Isotop. Radiat. Technol., 6: 85-93(Fall 1968).

An increasing number of monomers was shown to polymerize in the solid state. Gamma irradiation is the most useful method of reaction initiation because of its high penetration and relatively uniform distribution of active sites. Polymerization may occur by free-radical, cationic, and possibly anionic mechanisms. Electron spin resonance is a useful tool for following the course of free-radical reactions in the solid. Many polymerizations occur at phase changes, which are conveniently detected by differential thermal analysis. Some solid-state polymerizations are hindered by the existence of a crystalline lattice, but others are assisted. There is as yet no satisfactory picture of the kinetics of the solid-state polymerization process. (44 references.) (auth)

48888 CHEMICAL EFFECTS OF NUCLEAR REACTIONS IN SOLIDS. Fenger, Jes (Danish Atomic Energy Commission, Risoe). Fys. Tidsskr., 66: No. 1, 19-45(1968). (In Danish).

An elementary review of chemical effects of nuclear reactions in solids is presented with emphasis on the primary effects. (18 references). (Denmark)

48889 WATER REGIME AND SUPPRESSION OF WATER AND STEAM RADIOLYSIS IN THE BELOYARSK NUCLEAR POWER STATION. Kot, A. A.; Levich, A. A.; Shchapov, G. A.; Gruzdev, N. I.; Lesunov, I. P. Elektr. Sta., 39: 39-41(Jan. 1968). (In Russian).

Suppression of the radiolysis of water by hydrogen occurs in the reactor with the drum separator. With the presence of molecular oxygen in the contour water, the suppression of the radiolysis with hydrogen was apparently unobserved even with increase of the hydrogen content in the steam up to 88 nml/kg. Molecular oxygen is eliminated from the water contour with the hydrazine-hydrate determination. With absence of molecular oxygen in the contour, suppression of the water radiolysis in the reactor by hydrogen occurred with a concentration in the circulating water of only 1 to 2 nml/kg. When the content of residual oxygen in the circulating water does not exceed 0.02 to 0.03 mg/kg, the radiolysis of steam can be suppressed by hydrogen. With hydrogen content of only 40 to 45 nml/kg in the steam, the concentration of radiolytic oxygen in the superheated steam decreases to 0.03 mg/kg at steam pressure in the channel of 8.5 and 6.5 Mn/m^2, respectively, at the inlet and output. (tr-auth)

48890 RESISTANCE OF PLASTICS TO HIGH-ENERGY RAYS. Franck, Adolf (Technische Hochschule, Stuttgart). VDI (Ver. Deut. Ing.) Z., 110: 1105-9(Sept. 1968). (In German).

The plastics that are the most resistant to high-energy radiation contain aromatic atomic groups related to benzene. Non-resistant are those plastics with fully substituted carbon atoms in the molecule. The presence of oxygen is unfavorable especially over long-period exposure and if the wall of the plastic material is thin. (auth)

48891 IMPREGNATION OF CELLULOSIC MATERIALS WITH MOMOMERIC VINYL CHLORIDE WITH OR WITHOUT A DYE AND IN SITU POLYMERIZATION BY IRRADIATION. Feibush, A. M.; Kieltyka, H. P. (to United States Atomic Energy Commission). U. S. Patent 3,407,088. Oct. 22, 1968.

A method is described for increasing the tensile strength of wood bodies by subjecting the wood body to a vacuum, impregnating the wood body with monomeric vinyl chloride, and irradiation polymerization of the vinyl chloride within the wood body. (AEC)

48892 TRANSIENT SOLVATED ELECTRON, HYDROXYL, AND HYDROPEROXY RADICALS IN PULSE-IRRADIATED CRYSTALLINE ICE. Taub, Irwin A.; Eiben, K. (Carnegie-Mellon Univ., Pittsburgh). J. Chem. Phys., 49: 2499-2513(Sept. 15, 1968).

Neutral, crystalline ice samples were pulse irradiated in order to study phase and temperature effects on the properties of transient intermediates produced in radiolyzed water. These studies demonstrate that optical absorption bands with peaks near 670, at 280 ± 5, and 230 ± 8 nm are detectable. The transient visible absorption is attributed to a solvated electron e_s^-. Its spectrum, though unaffected by phase change, is influenced by temperature, dE_{max}/dT being -1.2×10^{-3} eV/deg. $G_{e_s^-}$ also depends on temperature, decreasing markedly from −5° to −40°C, but only slowly thereafter. The decay of e_s^-, which is second order at −14°C ($k = 1.5 \times 10^{11}\ M^{-1} \cdot sec^{-1}$) and partly first order from −40° to −100°C [$k(-60°C) = 1.1 \times 10^4\ sec^{-1}$; $\Delta E_{act} = 9 \pm 2$ kcal/mole], becomes slower with decreasing temperature. Overall spectral, yield and kinetic considerations indicate that e_s^- is structurally similar to e_{aq}^-, forms via pre-existing traps, and though immobile as a unit, decays both by reaction with H_3O^+ and by means of an equilibrial, mobile partner e_m^-. These findings are viewed in terms of the polaron theory and other models for the solvated electron. The transient 280-nm absorption is assigned to a hydrogen-bonded hydroxyl radical OH_t·. ESR data showing chemical and kinetic characteristics similar to the optical results confirm this assignment. Its molar extinction coefficient at −196°C is estimated as $\epsilon_{280} = 560 \pm 50\ M^{-1} \cdot cm^{-1}$ [using $G_{OH_t\cdot}$ (stable) = 0.8]. The overall OH_t· decay is complex. After prolonged irradiation, pseudo-first-order kinetics representing reaction with H_2 and/or H_2O_2 is primarily observed. For low doses and at temperatures below −100°C, separate fast and slow decaying portions can be distinguished, the former attributable to H· reacting with OH_t·, the latter to reaction involving only OH_t·. Based on an empirical $^3/_2$-order kinetic treatment [$k(-59°C) \leq 1 \times 10^4\ M^{-\frac{1}{2}} \cdot sec^{-1}$], ΔE_{act} for the slow decay is determined to be 5.7 ± 0.7 kcal/mole. Qualitatively, this decay and the reaction with products are reconcilable with a mechanism involving OH_t· in equilibrium with a mobile species OH_m·. Second-order kinetic behavior observed at −14°C (k appears to be $\sim 10^8\ M^{-1} \cdot sec^{-1}$) may also be consistent with this scheme. The full transient yield at −131°C is estimated to be 1.2. These findings imply that OH· is structurally different in both phases, but chemically similar. The relatively stable absorption at 230 nm is ascribed to HO_2·. Spectral, chemical, and possibly, ESR evidence support this identification. Its yield is low, and it decays only very slowly at −14°C. (auth)

48893 TAKASAKI: SECOND ERA OF THE CHEMISTRY OF RADIATIONS. Puig, Jean-Rene (CEA, Paris). Ind. At., 12: No. 7-8, 51-9(1968).
(In French).

The achievements of Japan in the field of basic and applied research in radiation chemistry are reviewed. All the phases of research, from the laboratory to the factory, are handled in this center. The Takasaki Center involves a financial contribution equal to that of all the other laboratories for radiation chemistry in Japan. (auth)

48894 REACTION KINETICS OF INTERMEDIATES FORMED IN THE RADIOLYSIS OF SOLID ETHYL IODIDE. Ogren, Paul Joseph. Madison, Wis., Univ. of Wisconsin, 1968. 166p.
Thesis.

Studies of the kinetics of radical reactions in irradiated solid ethyl iodide were carried out to gain information concerning the reaction mechanisms of these intermediates and to learn more about the radiation chemistry of solid alkyl iodides. The results suggest that at 77°K ethyl radicals produced in ethyl iodide glass by radiation are trapped in close proximity to one or more potential reaction partners and that such radicals disappear entirely by reaction with these neighboring species. At sufficiently high dose rates, the rate of ethyl radical removal is significantly greater than the rate of spontaneous decay of the radical concentration in the absence of radiation. Both tritium and cobalt-60 were used as sources of radiation. Particular advantages of tritium, incorporated into the ethyl iodide samples as C_2H_4TI, were that no ESR or optical absorption signals due to radiolysis of sample containers were produced and that samples could be studied over arbitrarily long periods of continuous irradiation. The tritiated samples were synthesized by producing $HI(H^3)$ from I_2, H_2, and T_2, and then adding the product to ethylene. Dose rates varied from 10^{14} eV g^{-1} min^{-1} to 7×10^{16} eV g^{-1} min^{-1} for tritiated samples, and from 10^{16} eV g^{-1} min^{-1} to 2×10^{18} eV g^{-1} min^{-1} for the cobalt-60 irradiations. In addition to the experiments carried out at 77°K, a few studies at both higher and lower temperatures were made. (TSS) (Disser. Abstr.)

Radiochemistry

Refer to abstract 48855.

Separation Processes

Refer also to abstracts 49010, 49060, 50699, and 50808.

48895 (CEA-R-3493) USE OF NUCLEAR RECOIL FOR SEPARATING ^{228}Ra, ^{224}Ra, AND ^{231}Pa FROM COLLOIDAL THORIUM. Beydon, Jacqueline; Gratot, Irene (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Apr. 1968. 8p. (In French). Dep.

By using α recoil it is possible to separate by dialysis the α disintegration products (^{224}Ra, ^{228}Ra) of thorium from colloidal

thorium hydroxide. The use of n,γ recoil allows the separation of ^{233}Pa produced by the neutron irradiation of thorium, on condition that the colloidal thorium hydroxide is irradiated in the presence of a dispersing agent. (auth)

48896 (IN–1192) THE PHYSICAL PROPERTIES OF NITRATE SOLUTIONS OF EBR-II FUEL ELEMENTS. Lewis, L. C. (Idaho Nuclear Corp., Idaho Falls). Aug. 1968. Contract AT(10-1)-1230. 16p. Dep. CFSTI.

Conductivity, viscosity, and density measurements were made on nitric acid solutions simulating those arising from the electrolytic dissolution of EBR-II nuclear fuel elements. Conductivity measurements were made at 25 and 50°C. Specific gravity measurements were made at 25 and 96°C. Viscosity measurements were made at 25°C. Equations relating viscosity with composition and specific gravity with composition and temperature were derived. The solubility of boric acid in these solutions was also determined. (auth)

48897 (KFK–709) AQUEOUS REPROCESSING OF NUCLEAR FUEL ESPECIALLY WITH HIGH-PLUTONIUM CONTENT. Baumgaertner, F. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Heisse Chemie). Dec. 1967. 23p. (In German). (EUR–3724). Dep.

The accelerating introduction of nuclear power plants and the development of fast breeder reactors using plutonium require expansion of the installations and methods for the reprocessing of nuclear fuels. The principal problems in the reprocessing of fuels with high plutonium content are the extreme toxicity of Pu and the criticality dangers. The critical masses for aqueous solutions are discussed, and the dangerous points in reprocessing procedures, such as precipitation, are considered. The solvent extraction method with TBP is described. The profiles of U and Pu distribution under various flow schemes are given. The principal problems still unsolved in the solvent extraction are outlined. (J.S.R.)

48898 (KFK-tr–249) TODAY'S POSITION AND SEVERAL PROBLEMS OF DRY REPROCESSING. Sugano, M. Translated into German by Peter Buriks (Kernforschungszentrum, Karlsruhe, Ger.), from Nippon Genshiryoku Gakkaishi, 9: 530-5(1967). 16p. (In German). Dep.

Several dry reprocessing methods for the recovery of uranium and plutonium from spent fuel are described. The advantages and disadvantages of each are summarized. The methods considered are pyrometallurgical methods (purification by fusion, extraction with a liquid metal, extraction with a molten salt, and methods working with both molten metal and a salt), pyrochemical methods (treatment of oxide fuels and treatment of carbide fuels, chloride volatility methods, and fluoride volatility methods). In the fluoride volatility methods the processing of alloyed fuels with highly enriched uranium, reprocessing of fuels with slightly enriched uranium, and semi-dry methods are considered. The economics of the fluoride volatility method are briefly discussed. (J.S.R.)

48899 (RFP–993) STATIC REACTOR REDUCTION OF PLUTONIUM HEXAFLUORIDE WITH IODINE AND HYDROGEN. Navratil, James D.; Wing, Ralph O.; Molen, Garrel F.; Moseley, Jerry D. (Dow Chemical Co., Golden, Colo. Rocky Flats Div.). Sept. 6, 1968. Contract AT(29-1)-1106. 12p. Dep. CFSTI.

Experiments are described that are part of an effort to develop and evaluate a plutonium hexafluoride volatility process for the recovery and purification of plutonium from a variety of impure materials. Hydrogen and iodine were used to reduce PuF_6 to PuF_4. With proper equipment and techniques, both reductants were found to be capable of quantitatively reducing PuF_6. PuF_4 from I_2 reductions was found to contain up to several wt % of metallic impurities. PuF_4 from the H_2 reduction contained from a few hundred ppm to several wt % of metallic impurities. The bulk of the impurities was traced to materials used in construction of the reactor. The results indicated that the H_2 reduction step should be investigated further. Details of equipment and procedures not described previously are included. Reduction bomb pressures and temperatures are given as well as physical and chemical data on the PuF_4 product. (auth)

48900 (RFP–1052) IMPURITY REMOVAL BY FLUORINATION OF PLUTONIUM DIOXIDE BETWEEN 28 AND 300°C. Navratil, James D.; Wing, Ralph O. (Dow Chemical Co., Golden, Colo. Rocky Flats Div.). Sept. 5, 1968. Contract AT(29-1)-1106. 8p. Dep. CFSTI.

Fluorination of plutonium dioxide between 28 and 300°C was investigated in a static-bed fluoride volatility system at Rocky Flats. Boron, chromium, molybdenum, silicon, tantalum, and titanium impurities were significantly removed from the plutonium dioxide after fluorinating at 300°C for 15 minutes. Less than 1% of the plutonium was volatilized during these fluorinations, and approximately 99% of the plutonium dioxide was converted to plutonium tetrafluoride. All effective impurity removal, for the system investigated, was accomplished in the initial 15 minutes of reaction. Conversion of plutonium dioxide to plutonium tetrafluoride was essentially complete within the same period of time. (auth)

48901 (RFP–1200) DISPOSAL OF FLUORINE. Navratil, James D. (Dow Chemical Co., Golden, Colo. Rocky Flats Div.). Aug. 29, 1968. Contract AT(29-1)-1106. 10p. Dep. CFSTI.

A literature review of fluorine disposal systems is presented. The review, containing 44 references, is complete as of April 1, 1968. Experimental work on fluorine disposal at Rocky Flats is also presented. Alumina, soda lime, and charcoal were evaluated as fluorine disposal media. Plugging of the disposal traps occurred regularly when alumina and soda lime were used. The use of charcoal reduced plugging problems, but a check valve was required to eliminate interference from small pressure surges resulting from the charcoal-fluorine reaction. In a given size trap, charcoal had twice the fluorine capacity for fluorine disposal, as compared to soda lime or alumina capacity. (auth)

48902 SEPARATION OF CHROMIUM, MOLYBDENUM, AND TUNGSTEN IN HYDROFLUORIC ACID SOLUTIONS BY USING ANIONITES. Pakholkov, V. S.; Panikarovskikh, V. E. Izv. Vyssh. Ucheb. Zaved., Khim. Khim. Tekhnol., 10: 168-72(1967). (In Russian).

The method is based on the adsorption of Mo(VI), W(VI), and Cr(VI) by anionite AN-2F, EDE-10P, or AV-17 (Cl^- form), with successive selective desorption of Mo with N-HCl, of Cr with 0.1N-HCl containing 5 g of Na_2SO_3 per liter (to reduce Cr(VI)), and of W with N-NH_4Cl containing 5% of NH_3. For the procedure—adjust the test solution to be 0.05N in HF, and pass the solution through a column containing 8 g of anionite (calculated as dry weight). Wash the sorbent with H_2O (this removes any Cr^{3+}), and elute with the above solution in the given order, at a rate of 1 ml per cm^2 per min. The separation is complete. Like Mo, the W is adsorbed predominantly as singly charged ions, apparently as $WO_2F_3^-$, and the adsorption is complete in the absence of competing ions. If HCl or H_2SO_4 is added to the W and HF solution, ion competition leads to a reduction in the sorption of W and in the breakthrough capacity. (Referat. Zh.)

48903 NUMERICAL METHODS FOR DETERMINATION OF THE DEGREE OF ^{18}O- AND ^{17}O-ENRICHMENT BY COUNTERCURRENT DISTILLATION OF WATER. Staschewski, Dieter (Kernforschungszentrum, Karlsruhe, Ger.). Chem.-Ing.-Tech., 40: 748-56(Aug. 1968). (In German).

In order to gain a quantitative description of the separation of oxygen isotopes by countercurrent distillation of water, the extended Cohen equations were integrated numerically by means of a computer program based on the Runge/Kutta process. The program permits calculation of stationary and nonstationary isotope enrichment with concentrating- and separating-columns and with combinations of both types. (auth)

48904 SOLVENT EXTRACTION OF SOME LANTHANIDES WITH 2,2,6,6-TETRAMETHYL-3,5-HEPTANEDIONE. Sweet, Thomas R.; Parlett, Henry W. (Ohio State Univ., Columbus). Anal. Chem., 40: 1885-8(Oct. 1968).

The stability of the chelates formed in the aqueous phase in the solvent extraction of lanthanides with 2,2,6,6-tetramethyl-3,5-heptanedione H(thd) was studied. All of the elements studied showed essentially 100% extraction from a pH of about 7 to 12.5. The formation constants for Pr, Sm, Eu, Gd, and Tb with H(thd) are tabulated. The stability of these lanthanide complexes was greater than the corresponding acetylacetonate or benzoylacetonate complexes. Separation factors for Pr–Sm, Sm–Eu, Gd–Tb, Eu–Tb, Pr–Tb, Sm–Tb, and Gd–Eu were calculated. Although Pr, Sm, Eu, Gd, and Tb can not be quantitatively separated from each other in a one-stage extraction with this extraction system, it does appear, on the basis of the separation factors shown, that many of these metals could be separated very well by a multiple extraction technique. (D.H.M.)

48905 ENHANCEMENT BY ZIRCONIUM OF EXTRACTION OF CATIONS BY ORGANOPHOSPHORUS ACIDS. I. MONOACIDIC PHOSPHONATES. Weaver, Boyd (Oak Ridge National Lab., Tenn.). Contract W-7405-eng-26. J. Inorg. Nucl. Chem., 30: 2233-41(Sept. 1968). (ORNL-P-3526).

The extraction of zirconium from aqueous solutions by monoacidic phosphonates (monoesters of phosphonic acids) produces compounds that are much stronger extractants for many cations than are the simple acidic phosphonates. The most highly enhanced extractions observed are those of some of the alkaline earths and the lighter trivalent lanthanides and actinides. With 2-ethylhexyl phenylphosphonic acid (HEH [ϕP]) containing zirco-

nium, extraction enhancement factors as high as 10^4 were observed for some alkaline earths. Other cations for which zirconium increased extraction include Li(I), Ag(I), Tl(I), Mn(II), Co(II), Fe(III), in chloride, Y(III), Pb(IV), and Pu(IV), but not Cs(I), Be(II), Cu(II), Ni(II), Zn(II), Cr(III), Fe(III) in nitrate, nor Sc(III). Enhancements varied with the anionic constituent of the aqueous solution. Enhancement is a complex function of the zirconium concentration. Hafnium and titanium are the only elements other than zirconium so far known to produce this enhancement. A suggested mechanism involves cation exchange with the hydrogen of a hydroxyl on a complex zirconic acid. (auth) (UK)

48906 EXTRACTION OF METALS FROM METAL ION-CATECHOL-QUATERNARY BASE SYSTEMS. Vrchlabsky, M.; Sommer, L. (Purkyne Univ., Brno). Talanta, 15: 887-94(Sept. 1968).

Methods are given for the extraction of iron(III), molybdenum(VI), titanium(IV), niobium(V), vanadium(IV), uranium(VI) and tungsten(VI) as ternary complexes with catechol and a quaternary cation such as n-butyltriphenylphosphonium, n-propyltriphenylphosphonium, tetraphenylarsonium, cetylpyridinium, cetyltrimethylammonium and 2,3,5-triphenyltetrazolium, the solvent being chloroform. By use of masking agents and pH control some of these elements can be separated from each other. (auth) (UK)

48907 EFFECT OF THE METALLURGICAL COMPOSITION OF ALUMINUM–URANIUM–SILICON FUELS UPON CHEMICAL REPROCESSING. Paige, Bernice E.; Rohde, Kenneth L. (Idaho Nuclear Corp., Idaho Falls). Nucl. Appl., 5: 218-23(1968).

More economical methods of manufacturing aluminum–uranium fuel elements used extensively in high thermal neutron flux reactors might be employed if the quantity of silicon allowed in the fuels could be substantially increased. Since silicon has created problems in reprocessing this type of fuel, various core and cladding alloys were examined for the effect of the silicon content dissolution, extraction, and solids production during dissolution. Dissolution rates in nitric acid were related to the metallurgical compositions of the alloys which, in turn, are related to their silicon content, but the effect was not sufficient to interfere with the reprocessing of the fuels. Emulsion stabilization, a problem during liquid-liquid extraction of uranium, is caused by the silicon, which dissolves from the alloy as the intermetallic phase $U(Al,Si)_3$. Silicon present in the alloy at a silicon:uranium atom ratio <1 is in the intermetallic fuel particle, while silicon in excess of approximately one atom per atom of uranium does not enter into the intermetallic phase and is present in the alloys as segregations of elemental silicon. This elemental silicon does not dissolve and remains in the dissolver solution as undesirable solids. (auth)

48908 ION EXCHANGE CHROMATOGRAPHY OF IRON, MOLYBDENUM, AND TITANIUM. Khattak, Mohammad Akram (Pakistan Council of Scientific and Industrial Research, Peshawar). Pakistan J. Sci. Ind. Res., 11: 19-22(Jan. 1968).

A method has been worked out for the rapid separation of iron, molybdenum, and titanium. A mixture of these cations in 0.1M hydrochloric acid is added to an anion exchanger and eluted with the same acid to remove iron and titanium. Finally, molybdenum is eluted with 1M hydrochloric acid. The mixture of the two cations (Fe(III), Ti(IV)) in 5.5 M hydrochloric acid is then adsorbed in an exchanger and eluted with the same acid to remove titanium and iron is finally eluted with water. (auth)

48909 REPROCESSING OF IRRADIATED NUCLEAR FUELS AND BREEDER MATERIALS FROM THORIUM REACTORS. Merz, E. (Kernforschungsanlage, Juelich, Ger.). Atomwirt., Atomtech., 13: 417-21(Aug.-Sept. 1968). (In German).

Work was concentrated on the development of practical head-end processes for the production of feed solutions for reprocessing by aqueous methods and on the technical realization of the basic known Thorex process. Nonaqueous methods are under consideration for the more distant future: first fluoride or chloride volatilization. Experiments are concentrating on combustion in a stream of oxygen, disintegration of the graphite matrix, and molten salt digestion of coated particles. Investigations into the possibilities of reprocessing spent fuel elements from fast breeder reactors in the Nuclear Research Center Karlsruhe led to the choice of an extraction process with TBP. The most important differences as compared with the usual Purex process concern the high plutonium and fission product concentrations and the increased radiation loading of the extraction medium. The hazards of an insufficient radiation resistance on the part of the extraction medium with highly spent fuel elements can be reduced if the core and the breeder mantle are processed together. This mixing results in an average burnup comparable with that of thermal reactors. Another point in favour of the Purex process is the possibility that it offers for processing the breeder fuels with other nuclear fuels in combined large installations, so leading to the greatest economy. The investigations so far have revealed no insoluble difficulties. Experiments are now planned in a small laboratory plant with fuel specimens having a burnup of up to 100,000 MWd/t. (auth)

48910 THE DISMANTLING OF IRRADIATED FUEL ELEMENTS IN THE WAK. Huppert, K. L.; Zimmermann, G. (Gesellschaft zur Wiederaufarbeitung von Kernbrennstoffen mbH, Leopoldshafen, Ger.). Atomwirt., Atomtech., 13: 426-32(Aug.-Sept. 1968). (In German).

The first German reprocessing plant WAK, now under construction, will use a process in which the fuel elements are mechanically dismantled in hot cells and the individual rods then cut into short pieces. The fuel (UO_2, PuO_2) is dissolved out from the pieces of fuel rod before it passes through the actual separation process. The cladding and structure materials are left as solid waste. The WAK was so designed both in respect of its technical conception and also of its size that operations can proceed immediately on an industrial scale. The experience gained in its building and operation should be available for later projects. The intrinsically costly equipment for the mechanical disassembly of fuel elements is justified by this function. (auth)

48911 EXTRACTION OF FISSION PRODUCTS FROM HIGHLY RADIOACTIVE WASTE. Van den Bossche, A. (Ingenieurgemeinschaft Kernverfahrenstechnik IGK, Dortmund, Ger.). Atomwirt., Atomtech., 13: 453-4(Aug.-Sept. 1968). (In German).

The separation of highly radioactive fission products eases quite considerably the problem of the storage and disposal of radioactive waste. Liquid highly active waste from reprocessing plants must be stored in containers which, because of the necessary cooling plants and filtered ventilation systems, entail high costs. Two radioisotopes from the waste fission product solution are meeting a steadily growing demand: cesium-137 and strontium-90. Various precipitation processes, ion-exchange processes, and solvent extraction processes were carried out with both these radioactive substances. (M.C.G.)

48912 NEW METHOD FOR STRIPPING ^{131}I FROM THE ANION EXCHANGE RESIN USED TO REMOVE RADIONUCLIDES FROM MILK. Walker, J. P.; Rehnberg, B. F.; Brooks, I. B. (Southeastern Radiological Health Lab., Montgomery, Ala.). J. Dairy Sci., 51: 1373-6(Sept. 1968).

An investigation was made to find an alternate stripping agent for the removal of ^{131}I from Dowex 2 X-8 20-50 mesh resin used to remove this nuclide from fluid milk. The agent currently utilized is 2N HCl, which has the disadvantages of causing extreme corrosion to the stainless steel equipment used in modern dairies and of being expensive. The chloride: citrate: phosphate charged resin was equilibrated overnight with $Na^{131}I$ and 80-ml portions were placed in 25-mm diameter, jacketed columns. The resin beds were rinsed with six bed volumes of deionized water, 0.25 bed volumes per minute, at 25°C and stripping solutions were passed through. The stripping solutions were NaCl and a mixed salt containing sodium chloride, sodium citrate, and monobasic sodium phosphate. The parameters controlled in this investigation included concentration, temperature, flow rate, and total volume. The optimum stripping technique was 30 bv of 1N NaCl solution at a flow rate of 0.5 bv/min at 71 C. The stripping efficiency was approximately 96%. This technique was calculated to save approximately $1,380.00 in raw materials and operating costs per 45,500 liters of milk processed during each total capacity run at the commercial scale project when compared with the 2N HCl stripping method. (auth)

48913 COMBINED PROCESS FOR REMOVING RADIOACTIVE IODINE AND STRONTIUM FROM MILK BY ION EXCHANGE. Stroup, W. H.; Reyes, A. L.; Murthy, G. K.; Read, R. B. Jr.; Dickerson, R. W. Jr. (National Center for Urban and Industrial Health, Cincinnati). J. Dairy Sci., 51: 1500-2(Sept. 1968).

Milk labeled in vitro containing iodine-131 and strontium-85 was passed through an anionic resin (fixed-bed contractor) in a chloride: phosphate: citrate: cycle, acidified to pH 5.3 with citric acid, and passed through a cationic resin (pulsed-bed contractor) in a calcium: magnesium: potassium: sodium: cycle. To acidify the milk, a metering system was developed, which maintained the pH of the milk between 5.25 and 5.40 during a 20-hr run. Analyses of the treated milk indicated that approximately 97% of the iodine-131 and 95% of the strontium-85 were removed. The anionic and cationic salt compositions and the microbiological flora of the milk were not significantly altered by resin treatment. Protein stability analyses indicated that the acidification caused some protein precipitation, while the flavor quality was acceptable provided the first 5% of the treated milk was discarded. (auth)

EARTH SCIENCES

Geology and Hydrology

Refer also to abstracts 48943, 48944, 49030, 49038, and 50887.

48914 (COO-689-100) CORRELATION AND CHRONOLOGY OF ORE DEPOSITS AND VOLCANIC ROCKS. Annual Progress Report. Damon, Paul E. (Arizona Univ., Tucson. Geochemical Section). June 1968. Contract AT(11-1)-689. 75p. Dep. CFSTI.

New equipment and methods improvements are described for analyses of argon, potassium, rubidium, strontium, and naturally occurring radioisotopes. High-temperature argon introduction experiments have continued. The dating of ore deposits of areas in the United States is discussed from these and previous experiments. K-Ar dating procedures, analyses, and the accompanying factors of volcanic rocks are presented. Geological and geochemical investigations of samples from southeastern Arizona and the Del Bac Hills are reported. Measurements of magnetic polarity on samples collected for dating are reported for late Oligocene-early Miocene time. New K-Ar dates are tabulated on samples from the Basin and Range Province areas and late Cenozoic basalts from the Colorado Plateau. Dating of samples from Questa, New Mexico, Tintic Mining District, Utah, Caribbean volcanic rocks, Kiwira basalt, Tanzonia, and Hagen-Tonstein sanidine is discussed. Geochemical behavior study of platinum metals from Arizona has begun. A modified scheme of CIPW calculation of normative mineralogy is listed. (J.C.W.)

48915 (K-1758) THE DISTRIBUTION OF ^{60}Co, ^{106}Ru, AND ^{137}Cs AMONG SUSPENDED AND DISSOLVED PARTICLES IN WHITE OAK LAKE. Lammers, William T. (Oak Ridge Gaseous Diffusion Plant, Tenn.). Oct. 3, 1968. Contract W-7405-eng-26. 20p. Dep. CFSTI.

White Oak Lake, a small impoundment that receives low level radioactive waste from the operation of the Oak Ridge National Laboratory, was sampled routinely during a 14-month period from November 8, 1966, to January 2, 1968. Each sample was centrifugally fractionated into selected particulate fractions and a dissolved materials fraction. These fractionations, made in the Biophysical Limnology Laboratory, were extracted primarily to determine the feasibility of employing centrifugal techniques for isolating and concentrating waterborne particulate materials for study. In addition, the objective of this study was to establish the relation between quantity, type, and surface- or bio-activity of the particles in a fraction and the accumulation of radionuclides by that fraction. The fractions isolated from samples of White Oak Lake water were subjected to radiochemical analysis. Linear correlations were calculated for several combinations of the data. From this statistical analysis and interpretation, the pattern of uptake and distribution of three radionuclides (^{60}Co, ^{106}Ru, and ^{137}Cs) in the aquatic environment is better understood. (auth)

48916 (ORNL-4259) ENGINEERING DEVELOPMENT OF HYDRAULIC FRACTURING AS A METHOD FOR PERMANENT DISPOSAL OF RADIOACTIVE WASTES. de Laguna, W.; Tamura, T.; Weeren, H. O.; Struxness, E. G.; McClain, W. C.; Sexton, R. C. (Oak Ridge National Lab., Tenn.). Aug. 1968. Contract W-7405-eng-26. 261p. Dep. CFSTI.

The development of the process to dispose of radioactive waste by injection in the earth is described. Subsequent experiments are explained. The geologic setting in the experimental Oak Ridge waste injection area is described. The engineering design of equipment and facilities is given. (J.C.W.)

48917 (YALE-2912-20) TRACE ELEMENTS IN NATURAL WATERS. Annual Progress Report, December 1, 1967-November 30, 1968. Turekian, Karl K. (Yale Univ., New Haven. Dept. of Geology and Geophysics). Aug. 31, 1968. Contract AT(30-1)-2912. 31p. Dep. CFSTI.

A neutron activation technique for the determination of molybdenum and chromium in less than 100 mg of rock or sediment sample was perfected. The abundance of molybdenum in some standard rocks representative of the crust indicates that previous crustal estimates may have been too low. Three deep-sea cores, dated by carbon-14 and thorium-230, were analyzed for molybdenum down their lengths and the rates of accumulation and their variations with time assessed. The two mid-Atlantic cores seem to show their highest rates of molybdenum accumulation at the last glacial maximum 18,000 years ago. This is not seen in the one Antarctic core analyzed. Using stream and deep-sea sediment data a rough material balance for molybdenum can be made. It requires that 50 to 90% of the molybdenum is removed in near-shore areas or other reducing environments. A neutron activation procedure for the determination of chromium and molybdenum in seawater was perfected. A seawater profile from the Sargasso Sea was analyzed for chromium. As the seawater that was analyzed was filtered through Millipore filters probably containing strong chromium contamination, the numbers obtained are probably high. A correction for the contamination gives a preliminary result that the deep water (4000 m) is lower in chromium by a factor of ten than water down to a depth of 1000 meters. A few additional data on the concentration of molybdenum in streams and revised neutron activation results on suspended matter in streams are reported. (J.C.W.)

48918 CONCENTRATIONS OF ^{222}Rn IN COAL MINES IN ENGLAND AND SCOTLAND. Duggan, M. J.; Howell, D. M.; Soilleux, P. J. (Radiological Protection Service, Sutton, Eng.). Nature (London), 219: 1149(Sept. 14, 1968).

The sample vessel contained a ZnS screen held at a negative potential. Decay of the radon atoms produced positively charged Ra-A atoms, which were attracted to the screen, and the radon concentration was determined from the number of α-particles emitted by the Ra-A and Ra-C^1 atoms. The median concentration for the 12 mines investigated was ~2pCi/l. (UK)

48919 ELIMINATION OF THE EFFECT OF CHEMICAL COMPOSITION OF ROCKS ON THE GAMMA-GAMMA DENSITY LOGGING. Charbucinski, Jacek (Instytut Techniki Jadrowej, Krakow). Nukleonika, 13: 403-12(1968). (In Polish).

The problem of the effect of the chemical composition of rocks on the gamma-gamma density logging is discussed. The possibilities of eliminating this effect by applying special filters are discussed. The results of measurements and calculations are given for filters of various kinds and thicknesses, the critical thicknesses for Pb, Fe and Cd filters are also presented. Measurements based on these data have been performed with the complex filters, each filter consisting of several different metals. The characteristics of these filters are discussed, and an optimal filter has been selected, and its density logging tested for various models. It has been shown, that the application of this filter reduces considerably the density measurement error, bringing it under certain conditions to the minimum value. The proposed optimal filter presents a combination of three plates: Pb-Cu-Cd, of an overall thickness of about 1.5 mm, and there is no difficulty in introducing it into a probe. (tr-auth)

48920 RANGE OF NUCLEAR METHODS FOR SOIL MOISTURE AND DENSITY MEASUREMENTS. Czubek, Jan Andrzej (Instytut Badan Jadrowych, Krakow). Nukleonika, 13: 517-33(1968). (In Polish).

Definitions of the range of nuclear investigation, such as the percent, effective, and standard error range are given. For neutron methods of soil moisture measurements the neutron flux or the moments of this flux have been calculated at the center of the limited sphere or cylinder under the assumption of one- or two-group and age approximation for the moderation of neutrons and for the diffusion of thermal neutrons. Different values for the range of this method according to the different approximations used for the calculations were obtained. However, it follows from all the approximations made that practically all the neutrons detected come from the range equal to three migration lengths. To obtain this value for the sand/water mixture, all up-to-date experimental values have been compiled and compared with the theoretical ones. At the same time the results given for the moderation length in sandstone/water and limestone/water have been summarized. Considering experimental results for the gamma-gamma method of the density measurement, the range of 50 g/cm^2 for the case when practically all scattered gamma quanta measured by the detector are taken into account has been obtained. (tr-auth)

48921 ENERGY DISTRIBUTIONS OF SCATTERED GAMMA RAYS IN NATURAL GAMMA LOGGING. Czubek, Jan A. (Instytut Badan Jadrowych, Krakow); Lenda, Andrzej. Nukleonika, 13: 391-401(1968). (In Polish).

The problem of the selection of conditions proper for the standardization of natural gamma logging measurements is discussed. The scattered gamma rays spectra for the uniform distribution of sources in a homogeneous, infinite medium were calculated by solving the integral transport equation for gamma rays with the help of three independent numerical methods. The spectra calculated served for the construction of integral gamma rays spectra

detected in a rock containing admixtures of radioactive elements such as ^{238}U, ^{232}Th and ^{40}K. The detector efficiency is assumed to be energy-independent, and the absorptive effect of the borehole is neglected. The chemical effect of the chemical composition (various Z_{eq} of rocks) on the total intensity detected is discussed; it was found that for univocal standardization of measurement conditions the gamma rays of energies above the discrimination level of 200 keV (400 keV for ores) should be detected. The perspective works on the univocality of the standardization procedure for natural gamma logging purposes are presented. (tr-auth)

48922 THE USE OF ISOTOPIC METHODS FOR DETERMINATION OF PHYSICAL PROPERTIES OF SOILS IN THE CONSTRUCTION OF THE GEOTECHNICAL CROSS SECTION. Jakubowski, Marian; Sapula, Jozef. Nukleonika, 13: 421-9(1968). (In Polish).

The practical results of using isotopic probes for measurements under field conditions (in situ) of such physical properties of soils, as the bulk density and moisture are reported. Depending on the type of the probe used, the studies may be conducted either on the surface or in cased boreholes of small diameters. The results of the measurements are presented against the geologic cross section of the regions in which river dams have been designed. Such physical properties of the soils, as the bulk density and moisture, obtained directly from the measurements, as well as the dry bulk density, porosity, and compactness calculated from these measurements, are shown along the whole section of the drill hole. The isotopic tests may be very rapid, provided a suitable light device is available to dig into soil casing of a diameter of 1.5 to 2 inches. A vibrating drill of the BC-9 type driven by an internal combustion engine is often used. An analysis of the method of isotopic research is included. Stress is laid on the high cost of the apparatus and its slight independence of the factors involved in field tests, in consequence of which the apparatus often works defectively. The insufficient sensitivity of the moisture probes when measuring moisture exceeding the limit of 20% is also emphasized. (tr-auth)

48923 MORE IMPORTANT RESULTS OF APPLYING RADIOMETRIC MEASUREMENTS IN DEEP BORE-HOLES. Sokolowski, Julian (Instytut Geologiczny, Warsaw). Nukleonika, 13: 503-16 (1968). (In Polish).

The advantages of applying gamma and n-gamma measurements for the correlation of deep bore-holes documentation of potassium-magnesium deposits, and estimation of the chances of prospecting deposits of radioactive elements are discussed on the basis of the results of investigations carried out for deep bore-holes in the petroleum industry. It is reported that by combining these results with those from electric logging complexes in the Rotliegende, Zechstein, Buntsandstein, Muschelkalk, and Keuper formations in the Sudetic Foreland along with complexes in Lias, Dogger, Malm, and Cretaceous formations, all Cenozoic formations in the Mongilno region were isolated. A bed of potassium-magnesium salt has been found and its extension determined in Zechstein (Stassfurt cyclotheme) formations on the Fore-Sudetic monocline. A series with a distinct radioactive anomaly has been found in the mottled Buntsandstein, which most probably corresponds to an increased content of radioactive elements. (tr-auth)

48924 SINGLE-WELL ISOTOPE METHODS IN HYDROGEOLOGICAL INVESTIGATIONS AS APPLIED TO DRAINING THE ADAMOW MINE. Bors, Jerzy; Czepkowski, Mieczyslaw; Szopka, Jan. Nukleonika, 13: 485-94(1968). (In Polish).

In the investigations carried out in 30 wells in the Adamów brown coal mine, single-well isotope methods have been applied for determining the direction and velocity of the horizontal flow of water. The data obtained point to the possibility of a rapid and accurate determination of the hydrogeological parameters by labeled atom methods, and the resultant economic effects give support to the wider use of these methods. The analysis of the results of measurements shows that the directions of flow in different wells but at the same waterbearing level are characterized by similar azimuths, giving a general direction for the area investigated such as chalk level, azimuth 130 to 160°; level of sands over the coal bed, azimuth 50 to 100°. The filtration rate in the waterbearing top layers increases, as a rule, with depth, whereas in chalk beds it decreases. The investigations performed throw considerable light on the problems involved in the application of isotope methods on a wider scale in practice. (tr-auth)

48925 SOME PROBLEMS OF MEASURING SOIL DENSITY WITH GAMMA PROBES CONSTITUTING A PART OF THE GGW TYPE ASSEMBLY. Dabek, Mieczyslaw; Muras, Karol (Technical Univ., Lodz). Nukleonika, 13: 547-60(1968). (In Polish).

Results of investigations on the measurement of soil density in situ by means of radioisotope probes of GP and GO type, manufactured in Poland, and an absorption densitometer are given. Special stress has been laid on the effects of the chemical composition, moisture and heterogeneity of the soil on the results of density measurements. If this effect is disregarded, the bulk density determined by this method may be burdened with a considerable error. The quality of the apparatus, the optimal length of the GO-65 probe and other related problems are also discussed. (tr-auth)

48926 USE OF RADIOISOTOPES IN INVESTIGATIONS OF MIXING WASTE WATERS WITH SURFACE BODIES OF WATER. Baranski, Leslaw (Instytut Techniki Jadrowej, Krakow); Korbel, Kazimierz; Zuber, Andrzej. Nukleonika, 13: 466-83(1968). (In Polish).

Methods of tracing the mixing of waste waters with the Vistula river water using radioisotopes are described. The results obtained point to such factors as the shape of the river bed, flow rate, turbulence, flow velocity, kind of banks which exert a major effect on the mixing process. It has been found that distance from the point of discharge for complete mixing depends largely on the ratio of wastes to river water and on the kind of wastes introduced. (tr-auth)

48927 RADIOISOTOPE MEASUREMENTS OF THE FILTER TUBE DEPTH IN A BOREHOLE. Turkowa, Boguslawa (Instytut Techniki Jadrowej, Krakow); Umiastowski, Krzysztof; Zawadzki, Jerzy. Nukleonika, 13: 383-90(1968). (In Polish).

To localize a filter in a borehole with a casing, use was made of the difference in density between the perforated and unperforated parts of the casing. The density measurements were performed with a gamma-scattering probe. The theoretical calculations of the various design parameters affecting the measurements in a half-space geometry were performed by the Monte-Carlo method. The field measurements performed with the probe in accordance with the theoretical assumptions, yielded satisfactory results. (tr-auth)

48928 RUBIDIUM–STRONTIUM CHRONOLOGY AND GRANITOLOGY. Allegre, C.; Dars, R. (Groupe de Recherches Geochimiques Louis Barrabe, Paris). Geol. Rundsch., 55: 226-37 (1966). (In French).

The use of the Rb–Sr dating method depends on the ratio $(^{87}Sr/^{86}Sr)_{initial}$. One method considers this constant and equal to 0.712 or 0.708; another assumes that it is not constant and that the value depends upon geochemical and isotopic behavior of the elements. The present study uses radioisotopes and their products as tracers for geological phenomena, particularly the granitic phenomenon at the mineral level and then at the level of the entire rock. Three different models for evolution of the ratio are developed and analyzed; these are then applied to granites of the Anti-Atlas and the Montage Noire. Treatment is carried out for apatite, feldspar, muscovite, biotite, and the total granite. (BBB)

48929 TRITIUM CONTENT IN GROUND WATER STOCKWORKS. Matthess, Georg; Thilo, Lutz; Roether, Wolfgang; Muennich, Karl Otto (Hessisches Landesamt fuer Bodenforschung, Wiesbaden, Ger.). GWF (Gas Wasserfach), 109: 353-5 (Apr. 1968). (In German).

A preliminary report of ^3H dating of a groundwater system under different conditions is made. Under an extended aquiclude (Schluechterner Becken, Schluechtern, Germany) the methods shows a groundwater flow with a velocity of 30 to 60 cm/day. With horizontal limitation of aquicludes (Oberrheintal, Germany), the penetration is irregular. Data for ^3H content include location of site, depth of the layers used, geolological age of the water conducting layer, size and geological age of the sealing layers, ^3H content, ^3H age, length of flow, and flow velocity; these values are tabulated. An increase in ^3H is anticipated as time progresses from atomic tests. Further data will permit a more accurate analysis of this increase. (BBB)

48930 TRACING WITH ACTIVABLE TRACERS. PART II. Greene, Ralph E. Isotop. Radiat. Technol., 6: 70-6(Fall 1968).

The basic and theoretical aspects of the use of the stable-tracer activation-analysis method for water-resources investigations are reviewed briefly, and the selection of suitable materials and conditions—i.e., activable tracers, tracer nuclear properties, and tracer concentrations; procedures for sampling, activation, chemical separation, and measurement; corrections for background; sensitivity; and cost—is discussed in some detail. (57 references) (auth)

48931 RADIOACTIVE TRACERS AND CONTROL SURVEY MONUMENTS. Barker, Harold Jr. Surv. Mapp., 27: 613-19 (Dec. 1967).

Radioactive monazite was incorporated into control survey markers to facilitate their detection when used as uniform survey base control monuments. Simulated test monuments were constructed as cylinders 10 in. high and 8 in. in dia, composed of a 1:2:3 fine aggregate concrete. The mix was made stiff to prevent settling of the tracer, and a 1.5-lb ungraded crushed

sample of monazite was evenly distributed in the top 2 in. of the form. In the most sensitive range, the radiation survey indicator needle was driven completely off scale at an average distance of 3.5 ft from the source. A simulated monument buried under 0.5 in. of packed soil showed unmistakable activity at a distance of 3 ft, and maximum effect directly over the source. Reburial to 6 in. produced activity at 2.5 ft; 8 in. of cover caused no response except directly over the source. Beyond this depth, no activity was noted except on the ground surface over the simulated monument. Soil density did not cause significant changes in readings per unit of depth, but water content absorbed radiation so that capture distance was reduced by 50% at a burial depth of 6 in. The installation of a radioactive monument containing 1.5 lb of monazite increases the available search area from 0.44 ft^2 for a 9 in. dia control station, to a maximum of 7.1 ft^2 for a radiation circle 3 ft in dia, or a net maximum increase of 1610% under minimum burial conditions. For a two-marker disk configuration, the search area reaches a maximum of 14.2 ft^2 for a net increase of 3220%. The method adopted should produce future high recovery rates in areas with poor physical ties when a sufficient number of radioactive installations are available. The procedure, therefore, is designed for the long run, and its full effectiveness will not be felt for a number of years. Procedural recommendations adopted for radiological precautions are discussed. (BBB)

48932 NATURAL RADIOACTIVITY OF 250 FRENCH MINERAL WATER SPRINGS. Remy, M. L.; Pellerin, P. (Service Central de Protection contre les Rayonnements Ionisants, Le Vesinet, France). Bull. Inst. Nat. Sante Rech. Med., 23: 23-61 (Jan.-Feb. 1968). (In French).

There are 1400 thermal springs in France, about 1000 of which are developed for use. A preliminary study was made of radioactivity in 250 of these. The elements studied were natural radioactive elements with long half lives (natural U, ^{226}Ra, and natural Th). Radon-222 was not studied at this time since little activity in water from it has been observed, although its α radiation may be important in mineral water treatments. Potassium-40 and artificial radioactivity, including fallout, are also mentioned. The essential characteristics of natural radioactivity of water were studied. Uranium content in water was found to average 70, Th 18, and ^{226}Ra 10^{-4} $\mu g/l$. The location and composition of the spring waters are given. Relative importance of radioactivity of mineral water springs on their health-giving properties was considered. A table is given showing maximum activity allowable, as well as corresponding concentrations for ^{226}Ra, U, and Th. (BBB)

48933 ON THE RADIOCARBON AGE OF THE OCEAN WATERS. Miyake, Y.; Saruhashi, K. (Meteorological Research Inst., Tokyo). Pap. Meteorol. Geophys. (Tokyo), 17: 218-23(Dec. 1966).

The radioactive decay rate of radiocarbon in the ocean (1.5×10^{-11} g/m^2 yr) is much smaller than the rate of biological uptake and regeneration of inorganic radiocarbon from organic matter (1×10^{-10} g/m^2 yr) and the exchange rate at the air-sea interface (2×10^{-10} g/m^2 yr). Therefore, the radiocarbon age of sea water is controlled not only by radioactive decay but also by these other factors. This is the reason for the higher age of the surface water in polar areas. The radiocarbon age of sea water in the deep layers of the oceans is determined by radioactive decay, the exchange of inorganic carbon between the surface and the deep layers and regeneration of the inorganic carbon through biological decomposition. Owing to the smaller concentration of the inorganic carbon at the surface layer than that in the deep layer, the specific activity of radiocarbon in the deep layer tends to decrease through mixing with surface water, which gives a higher radiocarbon age to the deep waters. Calculations showed that when the residence time of the deep waters is 200 to 300 yr and that of the surface water is 5 to 7 yr, the apparent age is estimated to be about 1300 yr, which is in accord with the observations. (BBB)

48934 RADIOMETRIC DATING FOR GEOLOGISTS. Hamilton, E. I.; Farguhar, R. M. (eds.). London, Interscience Publishers, 1968. 514p. 147s.

The following papers are included in this treatise: potassium-argon dating of igneous and metamorphic rocks—P. E. Damon; comparison of the isotopic mineral age variations and petrologic changes induced by contact metamorphism—S. R. Hart et al.; Isotopic geochronology of Montana and Wyoming—B. J. Giletti; Interpretation of lead isotopes and their geological significance—E. R. Kanasewich; Interpretation of zircon ages—E. J. Catanzaro; Geochronological studies in Connemara and Murrisk, W. Ireland—S. Moorbath et al.; Radiometric dating and the pre-Silurian geology of Africa—T. N. Clifford; charged particle tracks: tools for geochronology and meteorite studies—R. L. Fleischer et al.; and isotopic composition of strontium applied to problems of the origin of the alkaline rocks—E. I. Hamilton. (UK)

48935 PROGRESS REPORT ON BUREAU OF MINES–ATOMIC ENERGY COMMISSION COREHOLE RIO BLANCO COUNTY, COLORADO. Stanfield, Kenneth E. (Laramie Petroleum Research Center, Wyo.). Quart. Colo. Sch. Mines, 61: 33-44 (July 1966).

In 1965 the Bureau of Mines with the assistance and cooperation of the Atomic Energy Commission drilled an exploratory corehole in Piceance Creek Basin, Colorado, to evaluate buried oil shales that might be amenable to fracturing by a nuclear explosive and subsequent recovery of oil by underground retorting. Preliminary results indicate continuous oil shales occurred at depths of 985 ft to the bottom of the hole at 2600 ft and may extend another 600 ft below the sampled interval. The γ-γ density and sonic logs indicate the continuous oil shale section (depths 985 to 2600 ft) averages about 22 gal of oil per ton. Present plans are to deepen the hole and take boroscopic photographs of an interval exhibiting poor core recovery. A second hole will be drilled at another site in the basin to locate thinner oil-shale beds under less overburden that may be more suitable for the proposed underground tests. An oil shale interval of this type would be more accessible for conducting in situ retorting tests. (BBB)

48936 THE FATE OF ^{14}C. de Saint-Blanquat, Henri. Sci. Avenir, No. 255, 408-15(May 1968). (In French).

Numerous errors which have now been demonstrated have caused the reconsideration of ^{14}C as a tool for archeological dating, though it has succeeeded in many unexpected tests. Irregular absorption of ^{14}C by trees has been demonstrated by dendrochronology; tests made with Sequoia gigantea show deviations only rarely exceeding 2% up to 3000 yr, but beyond that age much too great an age is read by ^{14}C methods. The problem of the cause of the variation in the ^{14}C level in the atmosphere over the epochs is noted. A deviation of 800 yr is found at objects dated 4000 B.C. by dating with Pinus aristata; other methods allow dating to 11,000 B.C. for comparison. At 6500 B.C. good correlation with ^{14}C dating is again found. Before this date a deviation of ^{14}C dating in the opposite direction (^{14}C age too old) is found. The study of paleoclimatic conditions is described with ^{14}C studies of corals. Effects of nuclear weapons testing on ^{14}C levels are noted with respect to dating procedures. (BBB)

48937 TRACER MEASUREMENT OF STREAM REAERATION. II. FIELD STUDIES. Tsivoglou, E. C. (Georgia Inst. of Tech., Atlanta); Cohen, J. B.; Shearer, S. D.; Godsil, P. J. J. Water Pollut. Contr. Fed., 40: 285-305(Feb. 1968).

A radioisotopic method is described for accurate and fully independent direct measurement of the gas transfer and reaeration capacity of natural streams. The field technique involves the simultaneous use of isotopes for dispersion and for dissolved oxygen. It was applied to the measurement of the reaeration capacity of a 17-mi reach of the Jackson River, between Covington and Clifton Forge, Virginia. Experimental and theoretical basis of the method is described. Evaluation of stream reaeration capacity involves the simultaneous release of 3 tracers (a fluorescent dye, a dispersion indicator, and a gaseous tracer). Instantaneous point dosing is used. Rhodamine-WT was selected as the most useful dye tracer because of its relatively small adsorptive losses. The dispersion indicator selected was tritium, in the form of ^3H_2O, and the gaseous tracer used was dissolved ^{85}Kr. If the fluorescent dye did not undergo losses to the stream bottom, the tritium would not be needed. The 3 tracers are released in the main river flow as a single homogeneous mixture. The dye provides information on time of flow and longitudinal dispersion, and indicates when to sample for the other 2 tracers. Tritium does not suffer absorptive losses, and provides an accurate measure of the total dispersion that has occurred in a river reach. Krypton-85, present in the dissolved state, undergoes the same dispersion as the tritium and, in addition, is lost to the atmosphere between sampling stations in accordance with the usual laws for gas transfer. By measuring the relative concentrations of the ^{85}Kr and tritium at successive sampling stations, the losses of ^{85}Kr between stations can be evaluated with a high degree of accuracy and dependability, and a reaeration rate coefficient (k_2) for ^{85}Kr determined. The observed field measurement of a k_2 for ^{85}Kr can be converted readily and accurately to a k_2 for dissolved oxygen under the identical field conditions. Radiation safety of the method is considered. (BBB)

48938 ESTIMATION OF CHANGES IN THE WATER STATUS OF SOILS UNDER FIELD CONDITIONS FROM THE ATTENUATION OF β RADIATION BY WATER HELD IN ABSORBENT NYLON PADS. Newbould, P.; Mercer, E. R.; Lay, P. M. (Agricultural Research Council Radiobiological Lab., Wantage, Eng.). Exp. Agr., 4: 167-77(1968).

A new method for determining soil water changes is described

in which variation in the attenuation of β radiation by water held in Nylon pads is used to show changes in the water content of soil. The method enables sequential measurements to be made in narrow zones of soil under field conditions; the results are not influenced by the presence of soluble salts. Pads of absorbent Nylon are buried at different depths in the soil, and reflect changes in the water therein. A radioactive source and a G-M tube are placed on opposite sides of the pads, and the attenuation of β radiation is measured at appropriate intervals with fixed geometry. Since the attenuation of β radiation varies with the mass of material between the source and the detector, and the mass of absorber material other than water is constant, the apparatus can be calibrated to record changes in the water content of the pad. From these the water content of the soil can be inferred as in the electrical resistance method. A ^{90}Sr source (100 μCi) was used because of its long half-life (28 yr), the energetic β radiation of its short-lived daughter ^{90}Y (2.2 MeV), the absence of γ radiation, and the availability of small sealed sources bonded to metal plaques 8 mm in dia. A small thin-walled G-M tube (7 mm dia, sensitive length 16 mm, wall thickness 80 to 100 mg/cm^2) was used as the detector. Both were mounted on the lower ends of rigid Nylon tubes sufficiently long to reach to the bottom of the absorber assembly. (BBB)

48939 NATURAL GAMMA RADIATION IN NORTHEASTERN AND EAST-CENTRAL GEORGIA. Ritchie, Jerry Carlyle. Athens, Ga., Univ. of Georgia, 1967. 98p.

Thesis.

Thorium, uranium, potassium, beryllium-7, cesium-137, ruthenium-106, cerium-144, antimony-125, zirconium-niobium-95 and manganese-54 were found in soil samples collected in northeastern and east-central Georgia. Thorium concentrations ranged from 3 to 70 ppM with an average concentration of 15.8 ppM. Uranium concentrations varied from 1 to 10 ppM with an average of 3.7 ppM. The average thorium to uranium ratio was 4.3 : 1. Total potassium ranged from non-detectable levels to 4.8% with an average of 1.08%. Concentrations of thorium and uranium in outcrop soils were the same as non-outcrop soils. Potassium concentrations in outcrop soils were three times that of non-outcrop soils. Cesium-137 concentrations in outcrop soils were ten times greater than that in non-outcrop soils. Total gamma radiation ranged from 550 to 8900 cpm/kg or a 16-fold range in activity. Estimated dose rates ranged from 2.25 to 38.30 μR/hr or a 17-fold range. The average dose rate for the 132 soils was 10.65 μR/hr. The wide range in dose rates presents an ideal situation for studying biological effects of low level background radiation. A close correlation (r = 0.88) was found between aerial gamma radioactivity and dose rates indicating that gamma aeroradioactivity maps can be used to delineate areas with different background radiation. (auth)

48940 DISTRIBUTION OF THE $^{13}C/^{12}C$ ISOTOPE RATIOS OF PEAT, WOOD, AND CHARCOAL. Stahl, Wolfgang (Bundesanstalt fuer Bodenforschung, Hanover). Brennst-Chem., 49: 15-20 (Mar. 1968). (In German).

Techniques are described for isotopic analysis of 320 samples of peat, wood, and charcoal, in an investigation of the region of variation in these types of plant material. Combustion in a vacuum line with introduced O_2 was employed, though it was considered unnecessary to effect complete combustion; the studies were done in parallel with ^{14}C studies. Reproducibility by the method cited was found to be 0.7 per mil. Mass spectrometric analysis was used to determine $\delta\ ^{13}C$. There were 2 maxima in the wood sample values for 52 samples, but the existence of 2 maxima could not be confirmed statistically; the average standard deviation was -27.0 per mil. Charcoal values were at -25.2 per mil from the standard (PDB). Little correlation between the $\delta\ ^{13}C$ values and the ^{14}C age was found. Similar results were obtained for peat samples, with little ^{14}C correlation again. Peat samples are analyzed according to origin, and the interpretation of isotope ratios is discussed for different kinds of samples. (BBB)

48941 BACKGROUND RADIATION IN THE COASTAL (MONAZITE) AREAS OF KERALA (SOUTH INDIA). Kartha, K. I. P. (Medical Coll. Hospital, Kerala, India). Health Phys., 15: 368-9(Oct. 1968).

Preliminary studied indicated excess background radiation in these monazite sand areas, leading to an attempt to measure this radiation using survey meters and LiF dosimeters, the former being employed to estimate radiation exposures within different types of residential houses. Average radiation exposures inside houses were found to be up to about 15 times normal. The LiF dosimeters were used to measure the radiation exposure to personnel living in the area; results indicated >7 times normal. (UK)

48942 AN APPLICATION OF THE RADIOACTIVE TRACER METHOD: A STUDY OF DISPLACEMENTS OF SEDIMENT IN THE COURSE AND AT THE MOUTH OF THE SEINE. Giresse, Pierre (Centre de Geologie Marine, Caen, France); Courtois, Guy. Rev. Geogr. Phys. Geol. Dyn., 8: 193-208(July-Aug. 1966). (In French).

Experiments were made with radioactive tracers to study the sand movements of the Seine River and its estuary because of evacuation of towns caused by sand displacement. Four sites were selected for the experiments. The first 2 were primarily in the sea and required an isotope with a fairly long half-life; so ^{198}Au with a 2.7-day γ emission was used. The other 2 sites in the river itself required an isotope with a longer period; so ^{192}Ir was used (with a 75-day period). The Campbell method was used for labeling sites 1 and 2 with ^{198}Au. The sand was washed with a nitric acid solution, rinsed, and dried. When the ^{198}Au was introduced in the form of a chloride, it adhered to the sand surface. With this process, 98% fixation can theoretically be obtained with 0.25 mg of gold per g of sand, and available activity is about 10 Ci of ^{198}Au per Kg of sand. At site No. 1, 3 Ci of ^{198}Au was fixed to 800 g of sand taken from the experimental area corresponding to 10^9 grains and therefore to an average of 3×10^{-4} μCi per grain. The 2 sites where ^{192}Ir was used were labeled by neutron activation of glass containing 0.3% by weight of Ir. Each tube immersed contained 40 g of glass, corresponding to 6×10^7 grains at site 3 (an average of 4×10^{-4} μCi per grain) and 4×10^6 grains at site 4 (an average of 3×10^{-2} μCi per grain). A description is given of the apparatus for washing, rinsing, and drying the sand and of the method of injecting ^{198}Au into the sand. Formulas were developed for the tonnage of sand displaced at each site. It was concluded that the isotope method produced satisfactory results. (BBB)

Meteorology

Refer also to abstract 50895.

48943 (AHSB(RP)-R-86) ENVIRONMENTAL MONITORING ASSOCIATED WITH DISCHARGES OF RADIOACTIVE WASTE DURING 1967 FROM UKAEA ESTABLISHMENTS. Wray, E. T. (ed.) (United Kingdom Atomic Energy Authority, Harwell (England). Authority Health and Safety Branch). July 1968. 23p. Dep. CFSTI. UK.

The results of the environmental monitoring undertaken to confirm that the discharges of radioactive waste during 1967 from each of the principal UKAEA establishments produced no hazard in the environment are described. The results of this monitoring are summarized and are compared with derived working limits to facilitate an appreciation of the standards of safety achieved. (auth)

48944 (IS-1924) SURVEY OF ENVIRONMENTAL RADIOACTIVITY FOR PERIOD JANUARY 1-JUNE 30, 1968. Voss, Milo D. (Ames Lab., Iowa). Aug. 1968. Contract W-7405-eng-82. 18p. Dep. CFSTI.

The environmental monitoring program of the Ames Laboratory of the USAEC for the Ames Laboratory Research Reactor (ALRR) is described. The environmental program consists of air samples, soil, vegetation, river water, bottom sediment, precipitation, pond water, ALRR outfall, and well water samples. The period from January 1, 1968 to June 30, 1968 is covered. As soil and vegetation samples are collected later in the year (usually August) that data will be reported. The ALRR reached full power as of July 12, 1965. As of December 31, 1967 the ALRR had generated 43,836 megawatts of heat. A total of 58,877 megawatts of heat has been generated as of June 30, 1968. The data indicate that the ALRR has not contributed a significant amount of radioactivity to the environment in the Ames area. The conclusion is reached that radioactivity levels recorded for environmental samples represent background conditions from atmospheric fallout and naturally occurring radioactivity. (auth)

48945 THE GROSS β RADIOACTIVITY OF FALLOUT COLLECTED AT THE SOUTHERN WEATHER STATION LOCATED AT 29°N and 135°E. Yoshimura, Hirozo (Japan Meteorological Agency, Tokyo). Oceanogr. Mag., 19: 169-72(Dec. 1967).

Fallout samples have been collected aboard the observation ship near the marine weather station, "Tango" (29°N, 135°E), every summer since 1957. To collect fallout samples, a sheet of gummed paper was spread on a flat plate on a bridge of the ship. Measurement of gross β activity was performed on the ashed paper. Several days to 20 days or more elapsed between measurement and sample collection. The measurement of the gross β activity should be done as soon as possible after the decay of short-lived daughter products of natural radioactive materials, but the measurements had to be made irregularly. In addition, there was some doubt about the collection efficiency of fallout by the gummed paper. Despite those uncertainties, the data on the gross β activity collected at the

southern weather station seemed to provide an indication of fallout levels. Comparison of the gross β activity data with the long-lived nuclide levels (^{137}Cs and ^{90}Sr) revealed the following: the amount of time lapse after a nuclear explosion; the amount of stratospheric radioactive fallout; and the effect of rainfall on the collection efficiency of fallout, especially a long time after an explosion. (BBB)

48946 DATA ON RADIOACTIVITY OF THE ENVIRONMENT AND FOOD IN HUNGARY. Bozoky, Laszlo; Kovacs, Jozsef; Predmerszky, Tibor. Idojaras, 71: 281-4(Sept.-Oct. 1967). (In Hungarian).

The data of rainfall radioactivity from 1962 to 1964 are given. The figures represent the mean of 3 observation stations in Budapest, as well as the mean of 4 stations from both the Eastern and Western parts of the country. Some 58 rivers were analyzed by samples obtained from 127 places. The mean radioactivity of rivers amounts to 0.17×10^{-7} μCi/ml. The artificial radioactive contamination in food products was examined during 1960 to 1965 from among spinach, lettuce, and garden sorrel. At that time milk was also systematically inspected. The inspection of environmental radioactivity is discussed. (Meteorol. Geoastrophys. Abstr.)

48947 PERFORMANCE TESTS OF LARGE-AND SMALL-VOLUME DUST SAMPLERS. Kamiyama Moto (Japan Meteorological Agency, Tokyo). Kishocho Kenkyu Jiho, 18: 422-32 (June 1966). (In Japanese).

Dust samplers being used to measure radioactivity of floating dusts in meteorological stations were tested. The results obtained are as follows: Small- and large-volume dust samplers employ filter papers with diameters of 3cm and 11cm, respectively. In the test of continuous aspiration for 5 hours with Toyo No. 5 A filter paper, the large type showed 46.3 times as large aspiration ($300m^3/5$ hours), and 2.33 times as large flow velocity through filter paper as the small type. Radioactivity of collected samples was the same for the two. In the small type, when 3 filter papers were used, 70 to 80 percent of the total was in the first filter paper. The flow velocity of aspiration decreased with the increasing number of filter papers, and it became zero with 6 filter papers. It is preferable to avoid using filter papers combined. In comparing 5 kinds of meters, e.g., manometer, gas meters for domestic and business use, and U-shaped tube and biram for meteorological use, the biram is most suitable for the flow meter of the large type. In measurements with the cylinder biram, the flow velocity of the large type first decreased rapidly and became nearly constant about 200 minutes after the starting time; the five hours mean flow velocity was about 2/3 of that at the starting time. The outer wall temperature of the pump rose rapidly at first, and after 2 hours became nearly constant at about 60°C. The distribution of dusts on the filter paper was nearly uniform. (NSA of Japan)

48948 BULLETIN OF THE ATMOSPHERIC RADIOACTIVITY. NO. 49, APRIL-JUNE 1967. Taiki Hoshano Kansoku Seiseki, No. 49, 1-57(Apr.-June 1967). (In Japanese).

Tabulated data on the radioactivity in the atmosphere, rainwater, and airborne dusts measured at numerous Japanese stations from April to June 1967 are presented. (L.C.L.)

48949 BEHAVIOR OF JET STREAMS IN POTENTIAL FALLOUT SITUATIONS. Reiter, Elmar R. (Colorado State Univ., Fort Collins). Arch. Meteorol. Geophys. Bioklimatol., Ser. A, 17: 8-16(Apr. 1968).

In a study of radioactive fallout which occurred during November 1962 over the southern United States, an intrusion of stratospheric air could be traced within a stable layer, sinking through the vertical extent of the troposphere in 2 to 3 days. The flow of contaminated air was associated with a well-developed jet stream. Only part of the stratospheric air reached the ground in an anticyclonic jet branch, while a large portion of air contained within the stable layer continued to travel in the upper troposphere following cyclonically curved trajectories. Such splitting of the jet-stream flow has been observed on other occasions and it appears to occur regularly on the leading edge of well-pronounced jet maxima over the United States. The splitting of jet streams into several branches is explained by conservation of potential vorticity within an atmospheric layer moving over an obstacle. Such an obstacle may be a large mountain barrier, such as the Rocky Mountains, or a slow-moving dome of cold air in the lower troposphere, as is typical for cold outbreaks associated with strong jet streams. Radioactive fallout may be associated with cyclogenesis of certain intensity at tropopause level. Such instances are usually connected with the southward migration of cold anticyclones (cold domes) into which stratospheric air intrusions of stable layers are caught. The radioactive debris then is carried to the ground in these anticyclones. The presence of such a cold anticyclone enhances the splitting of flow contained within the stable layer of contaminated air. Thus, the anticyclone produces the dynamic conditions in the upper flow pattern, under which a part of this flow is separated from the jet stream and becomes part of the anticyclonic circulation, in which it sinks into the lower troposphere. (BBB)

48950 METEOROLOGICAL ASPECTS OF "DELAYED FALLOUT". II. RADIOACTIVE PARTICLES IN THE ATMOSPHERE: ORIGIN, TRANSPORT, AND REMOVAL. Lablans, W. N. (KNMI, de Bilt, Netherlands). Vierde Macht, 16: 111-17(July-Aug. 1967). (In Dutch).

The transport of particles in the troposphere is restricted to the hemisphere where the explosion took place, but even there is no homogeneous distribution because of the rapid return to the earth's surface by means of water (about 80%) and direct precipitation on trees, buildings, etc. The relation between the radioactivity of the precipitation in rain and the rainfall rate is given. The transport of particles from stratosphere to troposphere by means of processes related to the jet streams is discussed, and theories are compared. Examples are given. (tr-auth)

48951 METEOROLOGICAL ASPECTS OF "DELAYED FALLOUT". I. SOME GENERAL PROPERTIES OF RADIOACTIVE PARTICLES AND THE ATMOSPHERE. Lablans, W. N. (KNMI, de Bilt, Netherlands). Vierde Macht, 16: 95-9(June 1967). (In Dutch).

Solid particles containing ^{90}Sr and ^{137}Cs are the biologically most important components in the fallout of nuclear weapons. Particles present in the troposphere return to the earth in a few weeks, mainly by means of water precipitation. The stratosphere is meteorologically so stable, that particles below 1 μm diameter, deposited there by heavy or high-altitude nuclear explosions, may stay there for as long as 2 years. This implies that delayed fallout on the earth surface is determined by the transport of particles in the stratosphere and from there down into the troposphere. Thus fallout measurements contribute to the knowledge of, and stimulated research on, transport processes in the stratosphere and in the transition layer. (tr-auth)

48952 THE MEASUREMENT OF RIVERFLOW WITH RADIOACTIVE ISOTOPES WITH PARTICULAR REFERENCE TO THE METHOD AND TIME OF SAMPLING. Ward, P. R. B.; Wurzel, P. Int. Ass. Sci. Hydrol. Bull., 13: 40-8(Feb. 1968).

Methods of riverflow gauging with ^{198}Au and ^{51}Cr-EDTA involving withdrawal of sample from the river and measurement in situ were investigated in streams with flows of 10 to 250 ft^3/sec. The total count method was favored on account of its ability to sample large volumes and was found to give reliable results at short sampling distances. An extension of the method to conditions of non-infinite geometry using a probe in the stream is offered. The extended method allows in situ gauging of streams as shallow as 2 ft. An empirical method for prediction of tracer passage times from tracer arrival times is given, based on a series of measurement of tracer passage in rivers at low flow. Colloidal ^{198}Au was found to be insignificantly adsorbed over a measuring reach of 3000 ft. Flows of 5000 ft^3/sec and above require excessively large tracer amounts. This incurs problems of health hazards and great expense. The range of application of the total count method extends up to flows of 5000 ft^3/sec. In order to reduce the amounts of radioisotopes needed for measurement of large flows, methods where samples are withdrawn from the river and enriched are essential. (BBB)

48953 EVALUATION OF GLOBAL FALLOUT OF ^{55}Fe AS A RESULT OF NUCLEAR TESTS IN THE ATMOSPHERE DURING 1961 AND 1962. Hoang, C. T.; Servant, J.; Labeyrie, J. (Centre des Faibles Radioactivites, Gif-sur-Yvette, France. CEN, Saclay, France). Health Phys., 15: 323-32(Oct. 1968). (In French).

The ^{55}Fe fallout ($T_{\frac{1}{2}}$ = 2.7 years) for the years 1962 to 1965 in France was compared with that of ^{90}Sr and their ratio deduced for each year and for the latitude band between 40 and 50°N. A knowledge of the ^{90}Sr fallout for different bands of latitude during the same period allows deduction of the corresponding values of ^{55}Fe as well as the total amount of the ^{55}Fe fallout on the surface of the globe. For the period 1962 to 1965, the total amount was found to be 19 ± 2 MCi. (auth)

48954 RATIOS OF ^{95}Nb TO ^{95}Zr IN OVER-OCEAN FALLOUT. Noshkin, V. E. (Woods Hole Oceanographic Institution, Mass.). Nature (London), 219: 1241-3(Sept. 21, 1968).

The nuclides were measured in a series of Atlantic over-ocean aerosol samples collected by filtration between Jan. and May 1968, and from their ratios it was shown that samples from latitudes 0 to 41°N contained mixtures of fallout from two sources: the Chinese test on December 24, 1967, and the Chinese megaton explosion of June 17, 1967. It is interesting that the latter test, which was thought to have introduced most of its fallout relatively high in the stratosphere, was so consistently and so soon represented in subequatorial over-ocean air; also considerable variability

was observed in the relative contributions of the two sources. Germanium (Li) solid state gamma spectrometry was employed. Since meteorological processes involved in over-ocean fallout may differ from those over land, this possibility was examined. Zirconium-95 was determined by summing total emissions in the 724 and 756 keV photopeaks; ^{95}Nb was determined from its 765 keV photopeak. Ratios $^{95}Nb/^{95}Zr$ are shown plotted as a function of collection time. The persistence of a recognizable main debris-carrying cloud for more than 4 months after formation and for 5½ circuits of the globe was surprising, and suggests that some of the debris must have entered the upper troposphere or lower stratosphere. (UK)

Mineralogy and Exploration

Refer also to abstracts 48812 and 49003.

48955 (NIM-269) A LITERATURE SURVEY OF THE VERTICAL DISTRIBUTION OF GOLD AND URANIUM IN VARIOUS AURIFEROUS REEFS. von Rahden, H. V. R.; Hiemstra, S. A. (National Inst. for Metallurgy, Johannesburg (South Africa)). Jan. 12, 1968. 17p. Dep.

A survey of the literature from 1908 to the present was undertaken to collate data on the distribution of gold and uranium in sediments of the Witwatersrand System and the Dominion Reefs Series. The validity of some of the data examined is discussed. (auth)

48956 STUDY OF SOME RADIOACTIVE OCCURRENCES IN PEGMATITES OF THE CONGO AND RWANDA. Wambeke, L. Van (EURATOM, Ispra, Italy). Bull. Soc. Belge Geol. Paleontol. Hydrol., 76: 7-26(1967). (In French).

A description is given of some radioactive minerals in the Congo and their geochemical significance is discussed. Uranium and more rarely Th minerals occur in the sodalithic pegmatites of Buranga (Rwanda) and also of Mapembe and Liha (Congo-Kinshasa). The main radioactivity is generally concentrated in the minerals of the microlite series but also uranothorogummite and zircon (Mapembe), euxenite, tantalpolycrase, and tanteuxenite (Liha) may be present. Moreover, columbo-tantalites may have a low content of radioactive elements. This study showed that during the sodalithic pegmatitic differentiation which is characterized by a gradual increase of the Ta_2O_5/Nb_2O_5 ratio of the columbo-tantalates, the residual solutions become impoverished in radioactive elements. The result is that the microlites of the last generation, which have the highest content of Ta, are often devoid of radioactivity. (BBB)

48957 FUEL POLICY FOR THE 1970s. Engineering, 204: 819-22(Nov. 24, 1967).

The projected trends in fuel consumption in the U.K. for the next ten yr are discussed with particular emphasis on nuclear power. The costs of power production using coal, gas, and nuclear fuel are compared. It is concluded that for locations remote from coal fields power produced by nuclear plants is as cheap as power produced from coal, and that further reductions in the costs of nuclear power plants will occur. (L.C.L.)

48958 RAW ENERGY SOURCES FOR ELECTRIC GENERATION. Ritchings, F. A. (Ebasco Services Inc., New York). IEEE (Inst. Elec. Electron. Eng.), Spectrum, 5: No. 8, 34-45 (Aug. 1968).

The energy picture in the United States, through the year 1985, is outlined. Forecasts are made based on a number of factors, including economics, present and future estimates of fuel availability, relative plant size, transportation, and air pollution considerations. On a national basis, it is predicted that the consumption of all forms of raw energy for electric generation will increase substantially from now to 1985, with nuclear energy exhibiting the most dramatic absolute and relative gains. (auth)

48959 VARIATION OF Nb-Ta, Zr-Hf, Th-U, AND K-Cs IN TWO DIABASE-GRANOPHYRE SUITES. Gottfried, David; Greenland, L. Paul; Campbell, E. Y. (Geological Survey, Washington, D. C.). Geochim. Cosmochim. Acta, 32: 925-47(Sept. 1968).

Concentrations of Nb, Ta, Zr, Hf, Ta, U, and Cs were determined in samples of igneous rocks representing the diabase-granophyre suites from Dillsburg, Pennsylvania, and Great Lake, Tasmania. In the Dillsburg suite thorium and uranium increase from 2.6 ppM and 0.6 ppM, respectively, in the chilled samples to 11.8 ppM and 3.1 ppM in the granophyres. The chilled margin of the Great Lake suite contains 3.2 ppM thorium and 9.8 ppM uranium; the granophyre contains 11.2 ppM thorium and 2.8 ppM uranium. The average Th/U ratios of the Dillsburg and Great Lake suites are nearly the same—4.1 and 4.4 respectively. Within each suite the Th/U ratio remains quite constant. (auth) (UK)

48960 GENESIS OF URANIUM DEPOSITS IN THE VICINITY OF NAKATSUGO-OMBARA, NINGYO-TOGE MINE, OKAYAMA PREFECTURE. Suginohara, Masaaki (Power Reactor and Nuclear Fuel Development Corp., Japan). Kozan Chishitsu, 18: No. 87, 25-35(Mar. 1968). (In Japanese).

Uranium deposits in the vicinity of Nakatsugo-Ombara are distributed apparently on marginal terraces of an ancient river. The richest uranium ore occurs in the thinner basal conglomerate of which thickness is 2 to 3 m. In the best ore body of the Southern ore body (Nambu-kotai), the abundance of the uranium is closely related to those of S, P, Fe, Ni, and Co. Thus, the ore body can be classified into three zones by the zonal distribution of these elements from the center to the rim; Ni-Co-S-P-Fe-U zone, Co-S-P-Fe-U zone and S-P-Fe-U zone. On the other hand, abundances of these elements in the main ore body (Hon-kotai) of shale type are considerably lower. The uranium does not have a good correlation with S, P, and As. Koalinization and sericitization, regardless of the host rocks (i.e., conglomerate, sandstone, and granite), occur around these uranium deposits. This suggests that these alterations might have been genetically related to the mineralization. Montmorillonitization is also found. This alteration is, however, more closely related to the distributions of andesitic dikes in the granitic basement. Beside the bedded uranium deposits in conglomerate, sandstone, and shale, vein type minerallization occurs in the granite as lenses or veins. They are controlled by joints or dikes of aplite and andesite. The uranium deposits appear to have been due to an ascending ore solution of relatively low temperatures through cracks of the granitic basement. The uranium of the leached granite must have been enriched in the hot-spring-like solution. As soon as the solution reached to the conglomerate bed, the temperature was lowered by mixing with ground water and other physicochemical conditions might have been changed. Thus, the uranium was precipitated with such elements of the solution as P, S, Fe, Ni, and Co. The upper limit of the ascending solution was controlled by impermeable beds (mainly shale) and a ground water level at the time of mineralization. The uranium in the shale lying over the conglomerate was either a second origin dispersed from the conglomerate bed or a primary origin precipitated from the ore solution. (NSA of Japan)

48961 ANDERSONITE, A NEW URANIUM MINERAL FINDING IN AUSTRIA. Tufar, Werner (Aarhus Univ.). Neues Jahrb. Mineral., Abh., 106: 191-9(Apr. 1967). (In German).

X-ray diffraction and fluorescence spectrometric studies were performed on numerous U minerals, and the finding of a U mineral, andersonite, in gypsum deposits at Myrthengraben, Semmering (Lower Austria) is described. By these methods the mineral was identified as $Na_2Ca[UO_2(CO_3)_3] \cdot 6H_2O$. The gypsum deposits from which the mineral was obtained belong to Mesozoic strata. Fluorescence spectra of various U minerals are illustrated. The spectrum of andersonite found in Lower Austria was shown to be identical to that of a sample from the United States (Moab, Utah). Similar fluorescence spectra were obtained with schroeckingerite and meta-bayleyite but the former was broader than that of andersonite and the latter was narrower. The half-value width of the uranyl bands for meta-bayleyite was greater than that of andersonite while that of schroeckingerite was smaller. (BBB)

48962 DISCOVERY OF THORITE IN THE ALLUVIUM OF THE UPPER VALLEY OF THE ARVE (HAUTE-SAVOIE). Tourenq, Josette (Univ., Paris). Bull. Soc. Fr. Miner. Crist., 90: 267-8(Apr.-June 1967). (In French).

Sands of the upper Arve valley have a natural radioactivity of from 70 to 175 cpm. Those of Arveyron of Mer de Glace have the highest activity, 123 cpm; those of Diosaz the lowest, 58 cpm. The curve for radioactivity exhibits a parallel behavior to that for heavy mineral content. After treatment with $CHBr_3$ and CH_2I_2 and separation with the Frantz magnetic separator, mineralogical fractions were studied by autoradiography using Coppens' technique; results showed that the radioactive mineral was concentrated in the nonmagnetic fraction. The lengths of α-particle paths in a photographic emulsion indicate that the ratio of Th to U is 24 and that the value of C_{Th} is 43.6%. These values indicate a thorite, and this supposition was confirmed by a Castaing microprobe analysis. Distribution of the elements is homogeneous throughout the mineral. Consideration of the origin of the thorite suggests localization of thorite in the gneiss and micaschists of Gouter or in the protogine. (BBB)

48963 URANIUM RESERVES IN THE WORLD: CHECKED APPRAISALS. OECD-ENEA/IAEA-REPORT, DECEMBER 1967. At. Strom, 14: 60-8(Apr.-May 1968). (In German).

Revised appraisals were made of the uranium reserves in the world. The reliability of the appraisals was evaluated. The reserves present in seawater were estimated. The uranium re-

serves are tabulated for Argentina, Australia, Canada, Congo, Denmark, France, Gabon, Italy, Japan, Morocco, Nigeria, Portugal, Angola, South African Republic, Spain, Sweden, and the United States. (J.S.R.)

48964 THE URANIUM DEPOSITS IN THE VICINITY OF NAKATSUGO-OMBARA, NINGYO-TOGE MINE, OKAYAMA PREFECTURE. Suginohara Masaaki (Power Reactor and Nuclear Fuel Development Corp., Japan). Kozan Chishitsu, 17: No. 86, 39-49(1968). (In Japanese).

The Ningyo-toge area is one of the richest uranium areas in Japan. Uranium deposits of the eastern extension of the Ningyo-toge area are called the Nakatsugo-Nambu body, the Nakatsugo-main body, and the Ombara body, respectively. The average uranium content throughout these ore bodies is about 0.04% U_3O_8 or less, while high grade ore body of the Nakatsugo-Nambu averages over 0.5% U_3O_8. The ore reserve of the largest Nakatsugo main body are estimated to be about 430,000 tons (0.035% U_3O_8). The uranium deposits occur in a thin bed (0 ~ 90 m thick) of river or lake formations consisting of conglomerates, sandstone, and shale, successively from bottom to top. They overlie unconformably over various granitic rocks of the Chugoku Batholith, the age of which has been estimated to be from 33 to 64 million years. These sediments of the Miocene to Pliocene epoch, are covered by Pliocene andesite and/or andesitic pyoclastics. The uranium deposits are located at the northern edge of the main channel structure of a paleo-current. Since the trend of the major sheared zone and joints in granites are almost identical to that of the main channel, these weak zones of the granites might have favored the formation of the main channel. The highly mineralized horizon of the Nakatsugo-Nambu body occurs in the basal conglomerates above the granite. The ningyoite, which is the major uranium mineral of the ore body, fills the matrix of the conglomerates. It is usually associated with pyrite. On the other hand, the major uranium mineralization in the Nakatsugo main body is present in the basal conglomerates, and the minor one in alternations of sandstone and shale over the conglomerates although ningyoite is widely distributed, uraninite is present only locally in this ore body. The low grade ore body of the Ombara consists of uraniferous conglomerates, sandstone, and alternations of sandstone and shale. No uranium mineral has been identified at present. These ore bodies are the neogene bedded-type uranium deposits. It appears that the important geologic factors for the formation of these uranium deposits are surface and internal structures of the basement granite, amounts and kinds of the host sedimentary rocks, and presence of a cap rock. (NSA of Japan)

48965 URANIUM INDUSTRY OF CAPITALISTIC COUNTRIES IN 1965. Andrejew, W. D. Z. Angew. Geol., 13: 650-4(Nov.-Dec. 1967). (In German).

Industrial U reserves are given as U_3O_8 content in ore by % and in Kt for the year quoted: Canada, 0.12, 190.5, 1965; South Africa, 0.03, 172.4, 1966; USA, 0.235, 170.5, 1966; France, 0.14, 35.1, 1965; India, 0.1, 15.0, 1965; Australia, 0.1-0.2, 13.6, 1965; Spain, 0.11, 10.5, 1966; Portugal, 0.14, 6.4, 1965. Lesser values are given for Sweden, Morocco, Congo (Kinshasa), Gabon, Argentina, West Germany, Italy, and others. Mining of ore in million tons for 1964 and 1965 is as follows: USA, 4.8, 3.9; Canada, 4.7, 2.4; South Africa, 11.6, 7.5; France, 0.8, 0.8; Australia, 0.1, -; Gabon, 0.1, 0.1. Production of U concentrates in tons of U_3O_8 for 1964 and 1965 follows: USA, 10748, 9344; Canada, 6385, 3910; South Africa, 4043, 2674; France, 1150, 1150; Gabon, 518, 480; Australia, 335, 250; lesser values are quoted for the Malagasy Republic, Spain, Sweden, Portugal, West Germany, Argentina, and Congo (Kinshasa). The number and capacity of plants for U concentrate production in 20 western countries are tabulated. Discussion centers on developments in the USA, Canada, Euratom countries, with less notice of those in Nigeria, Tunisia, Uruguay, Turkey, Mexico, India, Japan, and Pakistan. (BBB)

48966 THE SELENIATE MINERALS OF THE URANIFEROUS POINT OF LIAUZUN-EN-OLLOIX (PUY-DE-DOME); CLAUSTHALITE, NATIVE SELENIUM, LEAD SELENIDE, AND CHALCOMENITE. Agrinier, H.; Geffroy, J. Bull. Soc. Fr. Miner. Crist., 90: 383-6(July-Sept. 1967). (In French).

In addition to plumbiferous guilleminite and native Se already described as occurring at Olloix, clausthalite, the only hypogenic bearer of Se observed, an anhydrous Pb selenide, and chalcomenite (a hydrated Cu selenite) have been found. Micrographs illustrate the quartz matrix with residues of pitchblende spherolites invaded by selenides and Se. The structure also shows pitchblende "atolls" (ring residues) on selenides and Se. An intimate mixture of pitchblende and α-uranotile such that the spherolite appearance is preserved is found. Pb selenide is in two crystalline forms, and in alternation with native Se. Association of Se with clausthalite is observed. Chemical tests and x-ray data support the assignment as Pb selenide. (BBB)

48967 URANIUM CONTENT IN ECLOGITIC INCLUSIONS FROM KIMBERLITE PIPES. Akimov, A. P.; Berzina, I. G.; Gurvich, M. Yu.; Lutts, B. G. (All-Union Inst. of Nuclear Geophysics and Geochemistry, Moscow). Dokl. Akad. Nauk SSSR, 181: 1245-8(Aug. 11, 1968). (In Russian).

Uranium content in eclogitic inclusions from kimberlite pipes Obnazhennaya and Slyredyanka in Eastern Siberia was determined using the method based on recording of U fission fragments produced by (n,f) reaction induced by thermal neutrons in specimens placed in a reactor. The formula for determining U concentration: $C = [2\rho\mu_U/N_0{}^{235}IdR_0\epsilon \int_E^\infty n(E)\sigma(E)d(E)]$ (where ρ is the density of induced fission tracks in a detector, μ_U is the uranium molecular weight, ^{235}I isotopic fraction of ^{235}U; N_0 is the Avogadro number, d is the density of the mineral or rock, R_0 is tracks of fission fragments in the minerals, ϵ is the efficiency of the recording of fission tracks, n(E) is the integral neutron flux $\sigma(E)$ differential fission cross section). The obtained new data on U content in minerals and rock can be used for determining the U balance in the upper layer and earth's crust and to verify the figures of mean clarkeite content based on Heier data. (R.V.J.)

Oceanography

Refer also to abstract 49182.

48968 APPLICATION OF RADIOACTIVE TRACERS IN THE SUBMARINE DOMAIN OF THE GULF OF LA NAPOULE. Pautot, Guy (Station de Geodynamique Sous-Marine, Villefranche-sur-Mer, France). Cah. Oceanogr., 20: 403-12(May 1968). (In French).

In addition to a tracer study of this region, the natural radioactivity was determined. Samples were taken parallel to and normal to the coast to determine the bottom activity and the results were mapped. At the mouth of the Frayere, a band of high activity (>125 counts/sec) was found parallel to the shore between the isobaths −2 and −5 m. Within this band pockets of activity higher than 150 counts/sec and even 200 counts/sec were found. Activity diminished gradually towards the coast and towards the sea. The same result was found near the mouth of the Taggia River. The maps were used to obtain diagrams of sedimentary dynamics and formed a basis for corrections for the ^{198}Au tracer studies carried out later. Comparison of natural radioactivity maps and morphology maps shows that in a general way natural radioactivity is lower in depressions and valleys, and higher in regions between the rivers. This behavior is suggested to be an effect of winnowing due to the current. (BBB)

48969 ON THE SUBMERSION OF RADIOACTIVE DECAY PRODUCTS IN THE OCEAN. Tomczak, Gerhard Gas-Wasserfach, 109: 541-2(May 17, 1968). (In German).

The submersion of 8000-Ci of wastes by the freighter Topaz in 1967, taken from ports in Germany, Holland, Belgium, France, and Britain in a combined action, was the result of several years of discussion. The site was chosen in the Iberian plain at a depth of 5000 m as a result of studies in that region by the German hydrographic institute. Special aspects of this ENEA action include cooperation (international disputes over previous attempts at burial are noted) and the publicity. Previous regulations of Euratom and the United Nations are shown to bear on sea burial of wastes, particularly actions of the IAEA in respect of Article 25 of the Convention on the High Seas. The determination of safe doses and limits in the Brynielson report are noted. Mixing and accumulation in plants and animals, and the resulting danger to man, create serious problems in view of our lack of knowledge of the sea. Legal problems should be settled by an international union; aspects of the Rousseau report are noted. Submersion of wastes must be abandoned when activity exceeds a minimum value. Methods of packaging and the forbidding of submersion of highly active samples are part of the convention. Future aspects of agreements on definitions of high activity, minimum depth, and suitable sinking areas are noted. (BBB)

Seismology

48970 (BARC-309) SOME COMPUTATIONS FOR DATA FROM LINEAR-CROSS SEISMIC ARRAYS. Arora, S. K. (Bhabha Atomic Research Centre, Bombay (India)). 1967. 26p. Dep.

Standard tables for a combination of time-lag along the two arms of the L-shaped Gauribidanur Seismic Array have been prepared block-wise to read directly the apparent signal velocity across the array and thereby enable direct estimates of epicentral distance and azimuth with respect to seismic events to be made. A wide range of 61 values of lags from −0.30 seconds to +0.30 seconds in steps of 10 msec are taken into account. These tables apply to all linear cross seismic arrays having a fixed spacing of 2.5 km between any two consecutive elements. In order to readily monitor a nuclear event, a table giving expected time-lags at Gauribidanur array for signals from certain known test zones is incorporated. Limitations on the application of these tables are also discussed. (auth)

48971 ESTIMATION OF PcP TRAVEL TIMES AND THE DEPTH TO THE CORE. Taggart, James; Engdahl, E. R. (Earth Sciences Labs., Boulder, Colo. Environmental Science Services Administration, Rockville, Md.). Bull. Seismol. Soc. Amer., 58: 1293-1303(Aug. 1968).

Based on a new P velocity distribution and observed PcP travel times from nuclear explosions, the core is estimated to have a mean radius = 3477 ± 2.0 km (depth = 2894 ± 2.0 km). Five velocity models were tested for the lowermost 90 km of the mantle. The PcP data suggest that the P velocity increases slightly with depth in this region. Tables of PcP travel times have been computed for the preferred model and a core radius of 3477 km. (auth)

ENGINEERING

Nuclear Explosions

Refer also to abstract 48970.

48972 COMMERCIAL APPLICATIONS OF NUCLEAR EXPLOSIVES: THE ANSWER TO OIL SHALE. Coffer, H. F. (CER Geonuclear Corp. Research Engineering, Las Vegas, Nev.); Spiess, E. R. Quart. Colo. Sch. Mines, 61: 69-89 (July 1966).

Numerous contained nuclear explosions have been conducted in tuff, alluvium, dolomite, granite, and salt. These tests indicate that nuclear explosives offer an economic method for breaking huge tonnages of rock underground, but whether or not such broken rock piles can be turned to commercial advantage has not yet been determined. Planned use of nuclear explosions in gas production, gas storage, copper leaching, and waste disposal is discussed, with emphasis on the economics. In the first 2 uses the application is straight-forward: fire the nuclear explosive and use the resulting rock pile (chimney) for the well bore or storage tanks. In the leaching and waste disposal prospects, however, the engineering to utilize the rock pile is an important factor. An analysis is also made of the use of nuclear explosives in recovery of oil from oil shale. Nuclear explosives can be used to form a large pile of broken shale, but whether this oil shale pile be processed to yield economic oil has not been answered. With the advantage offered by in situ retorting (no rock handling, no waste disposal problems) and the size of the oil shale target applicable to nuclear explosives, engineering of the process of retorting nuclear-created rock piles must be explored. A discussion of real or possible problems associated with nuclear explosive engineering is provided. The major problem is the seismic shock wave, which limits the size of explosive which can be used near important surface structures. The radiation problem is largely a psychological one in the case of contained explosions. Also described are the best areas in the oil shale for nuclear test programs and the limiting features such as thickness, depth, and richness of the oil shale. (BBB)

48973 ECONOMICS OF PRODUCING SHALE OIL: THE NUCLEAR IN SITU RETORTING METHOD. Lekas, M. A. (Atomic Energy Commission, Berkeley, Calif.). Quart. Colo. Sch. Mines, 61: 91-114 (July 1966).

Accumulation of experimental data on the nuclear in situ retorting technique, both from the standpoint of fragmentation of the shale with nuclear explosives, and the subsequent retorting, has progressed to the point where preliminary assessments are warranted on the concept and design of a commercial-scale plant, and those factors which influence in a major way the cost of producing shale oil by this method. Because of slow retorting rates and high initial rock temperatures, recovery of at least 75% of the in-place oil is considered likely in such a plant. In designing a plant with a fixed production rate and total recovery, the principal factors in determining the capital investment and per barrel cost of production are the thickness and grade of the shale. Production costs for crude shale oil are estimated to range from 29¢/barrel in a 1000-ft thick bed of 25 gal/t shale to $1.23 per barrel for a 200-ft thick bed. It appears that the technique can be applied successfully to lower grade shale, having an oil content as low as 15 gal/t. Production costs for this shale are estimated to range from 48¢/barrel for a 1000-ft thick bed to $1.16/barrel for a 400-ft thick bed. Estimates were made that indicated crude shale oil produced at a cost of $1.25/barrel in western Colorado could be profitably marketed in California. (BBB)

48974 NUCLEAR EXCAVATION: NOW FEASIBLE METHOD. Dyment, Robert. Constructor, 50: 49-53 (July 1968).

It is estimated that nuclear excavation would permit construction of a sea level canal to replace the Panama Canal in one-fifth the time and at one-quarter the expense of excavation by conventional means. Nuclear explosives could be used to overcome some of the formidable earth-moving problems involved if the proposed canal was constructed at sea level. However, a major question that must be resolved is whether or not any of the several canal routes would allow atomic excavation under the nuclear test ban treaty. Of many possible transisthmian routes which have been studied, 5 have been investigated in detail in relation to use of nuclear explosives. Feasibility studies indicate that digging a sea-level canal with nuclear explosives is practical and can be conducted safely. In addition, the canal would be larger than one dug by conventional means; thus, it should be more useful, less vulnerable, and should require less maintenance. Furthermore, such a canal dug by nuclear excavation methods would cost only a fraction of the cost to dig one by conventional methods. Costs of excavation over the 5 routes ranged from 620 to 2270 million dollars. The model project Dugout in which 5 charges of chemical high explosives buried in a row were detonated simultaneously at the Nevada Test Site is described. The explosives were detonated to form a channel in hard rock as part of the Plowshare Program. (BBB)

48975 PLOWSHARE IN AUSTRALIA. At. Energy Aust., 11: No. 3, 7-8 (July 1968).

Australian sites suitable for Plowshare operations were examined briefly by two U.S. experts for possible use in the creation of harbors, water storage facilities, and mining applications. The feasibility of such operations was discussed. (L.C.L.)

Facilities and Equipment

Refer also to abstracts 49049, 49063, 49409, 49416, 49706, 49720 49744, 49796, and 50093.

48976 (AEEW-R-580) IDENTIFICATION AND OPTIMIZATION STUDIES OF THE DYNAMICS OF A SMALL EXPERIMENTAL BOILER. Cummins, J. D. (Atomic Energy Establishment, Winfrith (England)). Oct. 1967. 175p. Dep. CFSTI. UK 24s. 0d.

A small experimental boiler was constructed and identification and optimization studies of the dynamic characteristics made. Steady state and transient measurements were made and a mathematical model of the dynamics of the system developed and compared against experimentally determined dynamic responses. The latter are derived by perturbing the heat input and continuous loop mass flow with a suitable pseudo-random binary chain code, and by then calculating on line the cross-correlation functions between responses—temperatures, water level and mass flows, and the perturbing signals. Equivalent impulse responses are determined in a digital simulation of the mathematical model. The model is then adjusted to give agreement with the experimental responses. This adjustment is performed by an optimization scheme based on the minimum mean square deviation of the two sets of system transient responses. (auth)

48977 (BNWL-691) PRELIMINARY RELIABILITY ANALYSIS OF THE PRIMARY ELECTRICAL POWER SYSTEM, SYSTEM 11. Monteith, O. B. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Feb. 1968. Contract AT-(45-1)-1830. 16p. Dep. CFSTI.

A preliminary reliability prediction for the Fast Flux Test Facility Primary Electrical Power System is reported. The effect of lightning (or unknown) surges on system reliability is included and the system availability is determined. A calculation of expected unavailability of the FFTF caused by system outages is presented. (auth)

48978 (BNWL-862) SODIUM JACKET FOR TEMPERATURE EQUALIZATION. Chulos, Leo E. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Sept. 1968. Contract AT(45-1)-1830. 12p. Dep. CFSTI.

A sodium-filled furnace liner was designed and fabricated of commercially available stainless steel tubing selected to provide an annulus of $\frac{1}{4}$ in. or larger, which was filled with sodium. The jacket was tested in a tube furnace. In using the sodium-filled jacket operator time was not required for equalizing the temperature along the gage section after the set-point temperature was reached. Measured temperature differences along the gage section were well within the ASTM recommended limits for creep testing. (F.S.)

48979 (CLM-R-93) SOME OBSERVATIONS ON THE OUTGASSING OF STAINLESS STEEL FOLLOWING DIFFERENT METHODS OF CLEANING. Barton, R. S.; Govier, R. P. (United Kingdom Atomic Energy Authority, Abingdon (England). Culham Lab.). Mar. 1968. 15p. Dep. CFSTI. UK 3s. 0d.

The quantity and temperature dependence of gas released by stainless steel in vacuo following various forms of cleaning have been investigated using a high resolution mass spectrometer. The samples to be studied were introduced through a series of vacuum locks into a small oven attached to the ion source of the mass spectrometer. Each sample was heated over a period of four hours to a temperature of 450°C at which it was maintained for 16 hours. After cooling it was exposed to the air for 24 hours and the amount of gas readsorbed was investigated by an identical procedure. (auth)

48980 (GEAP–5567) RADIAL VANE STEAM SEPARATOR DEVELOPMENT. Ninth Quarterly Report, Phase II, July–September 1967. Moen, R. H.; Kiss, E.; Gifford, J. E. (General Electric Co., San Jose, Calif. Atomic Power Equipment Dept.). Oct. 1967. Contract AT(04-3)-189. 51p. (EURAEC–1971). Dep. CFSTI.

Work performed under United States–Euratom Joint Research and Development Program.

Air-water tests of the radial vane separator modules (RVSM-1, -2, and -3) were carried out to check the readiness of these units for steam-water tests. The effect of a midvane support on carryover and carryunder was observed during these tests as well as measurements of water levels at various points to check usefulness of various measurement points for reactor tests. Steam-water tests of RVSM-1 were carried out which demonstrated good carryover and carryunder performance and pressure drop comparable to FCRV-3. Improvements to the design of the radial vane steam separator for KRB were included in the latest design drawing. Observations of air flow in the plenum of FCRV-4 were carried out to determine directions of flow in the plenum and through the nozzles. Analyses to aid the vibration studies were carried out. A correction to the water level equation for the lower vortex is presented. (auth)

48981 (GEAP–5655) RADIAL VANE STEAM SEPARATOR DEVELOPMENT. Final Report, Phase II. Moen, R. H. (General Electric Co., San Jose, Calif. Atomic Power Equipment Dept.). July 1968. Contract AT(04-3)-189. 27p. (EURAEC–2060). Dep. CFSTI.

Work Performed under United States–Euratom Joint Research and Development Program.

The design of a radial vane steam separator and related work was carried out as Phase II of the Radial Vane Steam Separator Development Program. This involved testing of a larger model separator, design of the separator and related studies, planning, instrumentation design, and model vibration studies. The program was terminated prior to completion because agreement on financial terms for a test in a boiling water reactor could not be reached. The results of that part of the program which was completed are summarized. The use of a radial vane steam separator still appears to be feasible, but a test of a reactor-size separator is required to prove this. (auth)

48982 (LMEC–68-20) LIQUID METAL ENGINEERING CENTER (LMEC). Quarterly Technical Progress Report, April–June 1968. (Atomics International, Canoga Park, Calif. Liquid Metal Engineering Center). Contract AT(04-3)-700. 112p. Dep. CFSTI.

Progress in the development of engineering standards and practices for liquid metal systems and components is reported. Drawings and specifications for reconstruction of the high pressure steam piping system for the Sodium Component Test Installation to obtain performance data on intermediate heat exchangers and steam generators under steady state and transient conditions were completed and fabrication contracts issued. Optimization and preliminary design studies for a large sodium pump and component test installation were completed. A thermal transient flow mixing and control analog computer program for use in the Sodium Pump Test Facility was developed. A site and the requirements for the Sodium Cleaning Facility were selected. Designs for the Seal Test Facility were submitted and the basic test rig for testing gas or oil type seals was completed. Overall conceptual design and test capability requirements for the hydrostatic and hydrodynamic bearing test facility were submitted. Static contact tests to determine self welding characteristics of 54 material combinations were completed. Sliding contact wear tests in sodium environments are summarized. The final system design for the HNPF pump test loop and the FFTF flowmeter position test were completed. Work on instrumentation standards is reported, and the evaluation of strain gages is presented in tabular form. Sodium level indicators for core, supply, and drain tanks were checked out. (F.S.)

48983 (N–68-25220) MISSION B EXPERIMENT DATA STORAGE AND RADIATION STUDIES. Holmes, G. B.; (and others) (Lockheed Missiles and Space Co., Sunnyvale, Calif.). Sept. 5, 1967. Contract NAS8-21003. 76p. (NASA-CR–61822; LMSC–A-842321). CFSTI.

In order to increase cluster shield radiation protection of films during prolonged space missions, plus x films and type 103-0 films were studied for effects of streaming flux upon total radiation damage to the spar mounted films. Dose estimates were made for a variety of parametric conditions and film dose versus shield weight values were obtained for side mounted and aft mounted camera configurations are given. (STAR)

48984 (NP–17626) EXPERIMENTAL LOOP, SKODA. Martinek, Jan.; Novotny, Karel (Skoda Works, Pilsen (Czechoslovakia). Nuclear Power Plant Div.). [nd]. 16p. Dep.

The CO_2-cooled heat transfer loop intended for research and testing of components for the cooling circuits of heavy water-moderated gas-cooled reactors of the type used in the A-1 power plant is described. The loop hot and cold circuits, laboratories and associated facilities, service facilities, and costs are discussed. (H.D.R.)

48985 (SC-DC–68-2410) STUDY OF PHASE TRANSITIONS IN INSULATORS BY THE DIELECTRIC CONSTANT TECHNIQUE. Samara, G. A.; Chrisman, W. L. (Sandia Corp., Albuquerque, N. Mex.). Aug. 1968. Contract AT(29-1)-789. 27p. (CONF-681005–1). Dep. CFSTI.

From Symposium on the Accurate Characterization of the High Pressure Environment, Gaithersburg, Md.

Measurement of the dielectric constant and dielectric loss is proposed as the operating principle of a probe for detecting and studying the properties of pressure-induced phase transformations in insulators. The measurement is very sensitive, relatively simple, and can be adapted for use in many types of high pressure apparatus. To illustrate the general usefulness of the technique, results on a variety of substances (solids and liquids) obtained from measurements in three different pressure apparatus are presented and discussed. The substances investigated include a number of alkali and thallous halides, strontium titanate, and water. (auth)

48986 (TRG-Report–1720) MOVABLE PERSONNEL SHIELD FOR ACCESS TO HOT CELLS. Edmonds, E.; Thomas, I. H. (United Kingdom Atomic Energy Authority, Dounreay (Scotland). Reactor Group). June 21, 1968. 9p. Dep. CFSTI. UK 2s. 0d.

With developing experimental techniques and changing objectives, personnel entry into hot cells from time to time is highly desirable. Even after extended remote clean down, radiation levels in hot cells working with high specific activity may restrict personnel entry to unreasonably short working time. A particular solution to this problem using a lead box to shield the operator has been used very successfully on many occasions. The technique and proposed developments of it are described. (auth)

48987 INDUSTRIAL IRRADIATION PLANTS. Oesterlundh, C. G. (Aktiebolaget Atomenergi, Studsvik, Sweden). Svensk Kem. Tidskr., 79: 539-48(1967). (In Swedish).

A technical account of industrial radiation processing plants is given. The major types of radiation sources, the ^{60}Co and the electron accelerators, are compared. It is emphasized that the choice of radiation source is closely governed by the requirements of the specific process to which it is applied. Some special engineering features peculiar to a plant for manufacturing wood-plastic composites are described. (17 references.) (Sweden)

48988 PORTABLE RADIATION SHIELD WITH IRON SAND. Hayashi, Katsuhiko (to Japan Atomic Energy Research Inst.). Japanese Patent 1968-3600. Feb. 14, 1968. Filed July 7, 1964.

The advantages of the proposed radiation shield are easy mobility, low cost, and easy build-up. An iron sand box-shaped wall is set upright at the end of a truck; at the top and bottom of the wall, holes, for introduction and withdrawal respectively of iron sand, are provided. The hollow wall is filled with iron sand. (NSA of Japan)

48989 RADIATION SOURCE CONTAINER, ALSO SERVING AS AN IRRADIATION DEVICE. Ibaraki, Tokuhiko (to Kimura Lead and Iron Chemical Machinery Co., Ltd.). Japanese Patent 1968-7277. Apr. 1, 1968. Filed Mar. 23, 1965.

By the method proposed, the container can also serve to irradiate samples, in addition to its function as a radiation source container. The space where radiation sources are contained is enclosed in a heavy mass. Radiation sources are taken out of the space from one end of the radiation source container by means of very long (desk) drawers. The shielding wall at the other end can be rotated horizontally. A protruding shelf is provided at one end of this wall, and samples to be irradiated can be placed on it. (NSA of Japan)

48990 DEVICE FOR DRYING IRRADIATED SAMPLES. Ogawa, Hiroyuki (to Nippon Atomic Industry Group Co., Ltd.). Japanese Patent 1968-5832. Mar. 13, 1968. Filed June 18, 1965.

Wet samples irradiated in a reactor, can be rapidly dried; and, further, radioactive dusts, adhering on their surface, can be removed in a safe manner. The device consists of the following: an inclined, long, cylindrical drain cage, through which the irradiated

samples can roll; a device, for blowing air onto the wet samples rolling down the cage; an inclined, long, similar cage, connected to the drain cage in a straight line; a device, for spraying a volatile washing-liquid onto the samples; and, finally, a device, for blowing drying air onto the washed samples. (NSA of Japan)

48991 CONTAINER FOR A RADIOACTIVE MATERIAL. Matsumoto, Tokutaro (to Japan Atomic Energy Research Inst.). Japanese Patent 1968-7276. Apr. 1, 1968. Filed Mar. 19, 1965.

The equipment and method used in the remote controlled closing of a container for radioactive materials is described. The advantages to the method are ease and absoluteness of covering the container with a lid by remote handling, and ease of container transport. A skirt, which has cuts (from the bottom side) at regular intervals, is attached to the (container) lid, forming the fringe. After placing the lid onto the container body, a belt is put around the skirt, and it is tightened; this operation is done by remote handling. A catch-knob is fixed on the lid at its center; and a ring packing is attached on the inside of the lid where it contacts with the container. (NSA of Japan)

48992 NUCLEAR-FUELED THERMIONIC CONVERTER EXPERIMENTS. Orr, W. L.; Edlund, M. C. (Babcock and Wilcox Co., Lynchburg, Va.). pp 183-94 of Fabrication of Ceramic Type Power Reactor Fuel Elements. VIII Nuclear Congress, Rome, 19-20 June 1963. Roma, Comitato Nazionale Energia Nucleare, 1967.

See CONF-193-(Vol.1).

A brief review of the principles and operation of thermionic converters is combined with a review and discussion of the results of in-pile heat transfer experiments. (P.G.C.)

48993 CONTAINER FOR RADIOACTIVE MATERIAL. Hiruta, Yasuo (to Hitachi Ltd.). Japanese Patent 1968-7275. Apr. 1, 1968. Filed Mar. 15, 1965.

A container for radioactive materials, e.g., damaged or irradiated fuel, is described in which the increase in internal pressure can be eliminated, leading to safety in the surrounding area; further, the internal volume, i.e., capacity, can be suitably adjusted. The container is made of a cylindrical body for containing the radioactive material, and an outer cylindrical body which telescopes over the containing cylindrical body. An axial series of notches are cut on the outside of the containing cylindrical body in the lower part, and a claw is installed on the outer cylindrical body at the edge of the (open) end so as to catch the notch by this claw. A means is provided on the outer cylindrical body for the engaging and disengaging of the notch by the claw. (NSA of Japan)

48994 RUSSIAN IRRADIATION FACILITY DEVELOPMENT. Isotop. Radiat. Technol., 6: 114-15(Fall 1968).

Two Russian irradiation facilities are described: the first USSR industrial radiochemical plant, which uses ^{60}Co in the manufacture of sulfonate detergents, and a commercially produced mobile irradiator, which uses ^{131}Cs for irradiating seeds prior to sowing. (auth)

48995 NEW ZEALAND EXPERIENCE WITH A ^{60}Co STERILIZATION UNIT. Rainey, H. B. (Tasman Vaccine Lab., Ltd., Upper Hut, New Zealand). Isotop. Radiat. Technol., 6: 93-9(Fall 1968).

The New Zealand ^{60}Co irradiation plant for sterilizing medical supplies is described, together with the bases for its establishment. (auth)

48996 EXAMPLES FROM CONSTRUCTION OF MODERN HIGH-PRESSURE APPARATUS. Witschakowski, Walter. Klepzig Fachber., 75: 283-6(May 1967). (In German).

Based on a series of examples from construction of high-pressure apparatus, differences between manufacturing instruments for chemical industry and those made for nuclear reactor use are examined. Whereas pressure and temperature are factors influencing the making of high-pressure devices, in chemistry an additional factor of protection against corrosion has to be taken into account. (tr-auth)

48997 THICK METAL PLATES FOR CONTAINERS FOR HIGH PRESSURES AND TEMPERATURES. Roux, J. H. Klepzig Fachber., 75: 323-5(May 1967). (In German).

For air-pressure tanks of heat-engine generating stations and for pressure tanks of nuclear power stations thick metal plates of special quality are needed. The technology of production of tanks, plates, end plates, and cylinders are explained as well as the metallurgical requirements and material specifications. (tr-auth)

48998 DETERMINATION OF RESIDUAL STRESSES IN A TUBULAR SYSTEM BY MEANS OF THE BORING METHOD. Cravarolo, L.; Miconi, D.; Sala, A. (CISE, Milan). Energ. Nucl. (Milan), 15: 588-601(Sept. 1968). (In Italian).

A theoretical analysis of tubular systems is given for determining the residual stresses by means of the boring method. Such a theory was investigated to determine its validity limits, taking into account particularly the errors due to possible anelastic yields taking place during the tubular system boring. (auth)

48999 IRRADIATION FACILITY WITH FLOODING AND DRAINING MEANS. Vidal, Pierre British Patent 1,116,959. June 12, 1968. Priority date Nov. 10, 1964, France.

The design of a facility for irradiation is given in which the chamber may be water flooded and drained for safety. Adjoining rooms have conveyor belts to place the products to be irradiated in the chamber. During preparation and positioning of the products in the chamber, the chamber is flooded. The chamber is drained during service. (J.C.W.)

49000 BRUTE FORCE PLUS SHOCKLESS CONTROL MOVE GIANT ELEVATORS. Hydraul. Pneum., 21: 90-1(July 1968).

The massive elevator complex at Hanford, Washington, which handles uranium fuel and services a reactor is described and illustrated. Installation specifications for the 4 hydraulic elevator required that they lift, lower, synchronize, automatically level, stop, and hold in any position. One elevator moves Zr-clad metallic U fuel loaded in storage tubes from a preparation room to wall storage racks and charge position in the reactor. Empty tubes are returned to the preparation room for reloading. The elevator is a 4-cylinder design, 64-ft 6-in. long × 31-ft wide, and travels 33 ft. The 2-cylinder elevator is 28-ft long × 13-ft 9-in. wide and has 43-ft 6-in. travel. It services the front face of the reactor for refueling and maintenance. Another 2-cylinder elevator services the rear face. A 4th elevator, 10-ft long × 8-ft 4-in. wide with 48-ft travel moves service personnel and freight. Specifications of the elevators are given. Highly critical factors involved in plant operation demand that the system start, lift, lower, and stop elevators smoothly without pulsation or shock. They must be waterproof against decontamination washdown, immune to radiation effects, have limited fluid leakage, and be efficient and reliable under extreme temperatures. (BBB)

49001 VAPOR GENERATING APPARATUS. (to Westinghouse Electric Corp.). British Patent 1,126,306. Sept. 5, 1968. Priority date Sept. 1, 1966, United States.

The design is given of a vertical vapor generator with a tubular outer shell. The design includes a vapor generating space in its lower portion, a vapor collecting space in the upper portion, and a vapor outlet at the collection point. Wall structures, inlets, and passageways are described. (J.C.W.)

49002 IMPACT EXTRUSION PROCESS AND BLANK FOR USE THEREIN. Donegan, Edward A. (to Atomic Energy of Canada Ltd.). U. S. Patent 3,391,563. July 9, 1968. Priority date Mar. 17, 1965, Canada.

A method is given of impact extrusion of ductile metal to form a tube. The blank consists of an annular pellet of ductile Zircaloy with inner and outer cylindrical sheaths of copper. The blank is rapidly extruded by the end pressure of a tool surface (with a further tool supporting the inner sheath) to form an elongated Zircaloy tube with inner and outer copper skins. (auth)

49003 ON THE HYDRAULIC MINING TEST FOR URANIUM DEPOSITS OF THE NINGYOTOGE TYPE. Takahashi, Tatsumi; Haraguchi, Hatsukichi (Power Reactor and Nuclear Fuel Development Corp., Japan). Nippon Kogyo Kaishi, 84: 279-81(Mar. 1968). (In Japanese).

A hydraulic mining test was carried out on the Ningyotoge uranium deposit, with the purposes of increasing the production by hydraulic excavation and transport, and improving the ore quality by cleaning effect. Investigations were made on such mining problems as facing, support, and transport. The advantages to this procedure are high efficiency in excavation and facing transport, and simplicity in concentration. The Ningyotoge deposit and ores, the testing facility and system, man-power requirements, mining procedure, excavation procedure, and pipe transport are described. (NSA of Japan)

49004 DEVICE FOR IRRADIATING WITH RADIATIONS. Imai, Ken (to Tokyo Shibaura Electric Co., Ltd.). Japanese Patent 1967-22875. Dec. 25, 1967. Filed Apr. 20, 1964.

A method is proposed whereby the amount of irradiation can be changed by the selective combination of a plurality of radiation sources. It consists of the radiation-source head, in which each of the plurality of radiation sources can be freely exposed to irradiate objects, the same number of manipulating levers installed in the operation room, and a means which connects each radiation source to its own manipulating lever. (NSA of Japan)

49005 CAVE-DAY METHOD FOR SCHEDULING HOT LABORATORY OPERATION USE. Murakami, Masatoshi (Japan Atomic Energy Research Inst., Tokyo). J. Nucl. Sci., Technol. (Tokyo), 5: 427-31(Aug. 1968).

A quantitative expression of the capacity of a hot laboratory for post-irradiation examinations and experiments should serve most usefully in scheduling hot laboratory operation. A method is described that has been termed the "Cave-day method." It has been in trial use for half a year since Feb. 1966. The method has proved to be highly useful for formulating and adjusting the operating schedule of the Hot Laboratory, once the standard times required for the various kinds of cave work have been determined. Another key to its successful application is a good understanding between the utilizers and the hot cave administration concerning the principles applied in determining the yearly or half-yearly amounts of cave-days allotted in advance to utilizers. (auth)

49006 DEVICE FOR CONTROLLING THE IRRADIATION. Kurihara, Shigeyasu (to Tokyo Shibaura Electric Co., Ltd.). Japanese Patent 1967-22876. Dec. 25, 1967. Filed Nov. 30, 1964.

A method is proposed for medical irradiations which has the advantages of highly accurate control of the irradiation in a given angular area, convenient remote control, and variety in irradiations. It consists of an irradiating device which revolves around the object, a position detecting device which emits a manipulating signal correspondingly to the angular position of the irradiating device, a light–electricity signal converting device in which the light source and its receiver move according to the manipulating signal, light-shielding belts which traverse the path of light, and, a means for controlling the irradiating device by electrical signals. (NSA of Japan)

49007 INDUCTION HEATING APPARATUS. (to Atomic Energy of Canada Ltd.). British Patent 1,127,290. Sept. 18, 1968. Priority date Feb. 24, 1966, United States.

An induction heating device used in induction brazing a number of joints simultaneously is described. The device is useful in joining wear pads or spacers to fuel element sheathings of metals such as Zircaloy. Before brazing the wear pads are tack welded with the braze alloy attached to the fuel element. The brazing device consists of a primary electromagnetic induction winding connected to a high frequency alternating current source. An electrically conducting susceptor is located in the winding to direct the field in the winding. To fix more pads to a tube, new susceptors are introduced at the desired longitudinal positions of the tube. (F.S.)

49008 IMPROVEMENTS IN ELECTRICAL GENERATORS, MORE PARTICULARLY FOR DELIVERING ELECTRICAL ENERGY IN PULSE FORM. Torossian, Antoine; Rebut, Paul Henri (to Commissariat a l'Energie Atomique). British Patent 1,125,100. Aug. 28, 1968. Priority date Nov. 26, 1965, France.

The design of an electric generator for discharging electrical energy in the form of unidirectional pulses is described. Powerful magnetic fields are produced without the necessity of delivering permanent currents. The generators are applied in experiments on plasma and in the nuclear power field. (J.C.W.)

49009 OPTIMIZATION OF A NUCLEAR POWER PLANT BY HYBRID COMPUTER. Kovacs, Joseph J. (Electronic Associates, Inc., Princeton, N. J.). Comput. Automat., 17: 26-31 (July 1968).

A nuclear power plant study performed with the aid of the 8900 Hybrid Computer System is reported. The objectives of the study that led to the use of a hybrid computer facility are described, the physical system is outlined, and the programming techniques that resulted in the computer model of the power plant are described. The primary objective was to examine the plant responses to a set of predetermined test cases. Subsequently, the optimal control settings were established to determine the safest and most economical plant performance. An automatic optimization method for the control system design was developed, and plant faults were simulated to determine plant behavior under fault conditions. Techniques of control system optimization were successfully demonstrated. Iterative optimization of controllers was found to be impractical. The best approach appeared to be the simultaneous optimization of all control parameters. Hybrid approach to nuclear power plant simulation is an economical one; evaluation of direct digital control is ideally suited for hybrid computation. The program structure agreed upon appeared to be satisfactory; the subroutine approach was easy to debug, and flexible to modify. In particular, the convenience and efficiency of the hybrid Fortran was demonstrated. The 10 times faster-than-real-time speed of the hybrid model gives speed advantage over the digital approach by a factor of 200; the economic advantage of the hybrid over the digital approach was found to be about 400 to 1; and the economic advantage of the hybrid over the pure analog approach was estimated to be about 50 to 1. (BBB)

49010 OPTIMIZATION OF A SOLVENT EXTRACTION PLANT TO PROCESS MONAZITE RARE EARTH NITRATES. Sebenik, Roger Frank. Iowa City, Iowa, Iowa State Univ., 1968. 69p. Thesis.

A new optimization technique is demonstrated by predicting the plant conditions which give the maximum return on investment for a solvent extraction plant which recovers 99.9% $La(NO_3)_3$ at a 99.0% yield from a cerium-free monazite rare earth feed. A combination of the steepest ascent and one-at-a-time methods of optimization to make systematic adjustments of six key plant operating variables are used which allow movement in a direction of increasing return on investment but always maintain the purity and yield at or near their specifications. The optimum return on investment is reached, with rapid convergence, from five widely separated starting points. The plant design calculations are programmed on the IBM 360 series digital computer to calculate the composition of streams, the size and cost of processing units, and the return on investment of the solvent extraction plant when the production rate in tons of rare earth feed per day and six operating variables are specified. Initially the program uses an adaptation of the Thiele-Geddes method in which iterative calculations are made using the five-solute system $La(NO_3)_3$–$Pr(NO_3)_3$–$Nd(NO_3)_3$–$Sm(NO_3)_3$–HNO_3–TBP–H_2O to obtain compatible equilibria and material balances for all streams of the internally fed cascade of mixer–settler stages. The size of each of the remaining process units is determined from material and energy balances, and then the cost of each unit is estimated from the size by employing a modification of the six-tenths method of plant scale-up. Each of the remaining capital investment costs and the variable manufacturing costs are estimated by using a recommended fraction of the total installed equipment costs. The ratio of the net profit to the total capital investment gives the return on investment of the plant. (Diss. Abstr.)

Heat Transfer and Fluid Flow

Refer also to abstracts 48976, 49001, 50072, and 50801.

49011 (AEEW-R-582) A COMPUTER PROGRAMME FOR THE SUBCHANNEL ANALYSIS OF THE HYDRAULIC AND BURNOUT CHARACTERISTICS OF ROD CLUSTERS. PART 2. THE EQUATIONS. Bowring, R. W. (Atomic Energy Establishment, Winfrith (England)). Jan. 1968. 60p. Dep. CFSTI. UK 9s. 0d.

HAMBO is a computer code for the steady-state hydraulic analysis of a rod cluster assembly cooled by a boiling fluid, using a subchannel model. The burnout characteristics of the cluster are determined by means of appropriate correlations applied to the subchannels. The physical model and use of the code were described in Part 1; Part 2 continues with the listing of the hydraulic equations and their derivation. The code is written in Fortran for the KDF9, and in Fortran S2 for the IBM 7030 computers. It is also available in Fortran IV for the IBM 7090. (UK)

49012 (AI-64-Memo-177) HEATING AND HEATING 2. A Program Description of a Generalized Heat Transfer Code for Solution of Transient and/or Steady-State Problems in One, Two, or Three Dimensional Cartesian or Cylindrical Coordinate Systems. Brunell, R. D. (Atomics International, Canoga Park, Calif.). [1964]. 85p. Dep. CFSTI.

HEATING and HEATING 2 are generalized heat transfer codes capable of solving transient and/or steady-state problems in one, two or three dimensional Cartesian or cylindrical coordinate systems. The simplified input of HEATING makes it a very useful code for those problems having geometrical configurations which can be described by parallel and perpendicular lines or planes, or concentric circles. These figures can be broken up into a maximum of 100 one-material regions with position and time dependent volumetric heat generation rates. Up to 40 materials with constant properties can be described, and the initial temperatures of these regions are position dependent. The boundaries of these regions can be contact, insulated, time dependent temperature controlled, or forced convection with a time dependent sink temperature. HEATING 2 differs from HEATING in that it can also have a radiation boundary with a time dependent sink temperature and a maximum of 750 nodes as opposed to the maximum of 1000 nodes of HEATING. (auth)

49013 (ANL-7430) A STUDY OF ONE- AND TWO-COMPONENT, TWO-PHASE CRITICAL FLOWS AT LOW QUALITIES. Henry, Robert E. (Argonne National Lab., Ill.). Mar. 1968. Contract W-31-109-eng-38. 77p. Dep. CFSTI. Thesis.

Two-phase, one-component critical flow was obtained in long tubes (L/D > 40) for mass flow rates of 512 to 6460 $lb_m/sec\text{-}ft^2$, exit pressures of 40 to 150 psia, and thermodynamic equilibrium qualities of 0.0019 to 0.216. Exit void fractions as well as axial void-fraction profiles were measured by a gamma-ray attenuation technique for void fractions of 0.07 to 0.94. These experimental void fractions resulted in velocity ratios that were considerably less than the existing analytical predictions. The one-dimensional and steady-state approximations are experimentally justified for high-velocity flows with the aid of the measured axial void-fraction profiles. Two test sections were designed to investigate the magnitude of two-dimensional effects at the exit plane. The two test sections were identical upstream of the exit plane. However, downstream of the exit, one test section diverged at a 7° included angle and the other at a 120° included angle. Results from these test sections indicate that previous experimental data are in considerable error for qualities below 10% because of the influence of the downstream two-dimensional expansion on the readings of wall-pressure taps located near the exit plane. Although temperature and pressure were not measured simultaneously, the data exhibit trends that suggest the existence of a nonequilibrium phase change. A model is developed to predict one-component, two-phase critical flow rates for equilibrium qualities less than 0.02. The model approximates the nonequilibrium processes of the real system by thermodynamic equilibrium paths and shows good agreement with the data for exit pressures of 50 to 150 psia. An analysis of the data and a comparison with the two-component data indicate that the phase change occurring in the flow is of a nonequilibrium nature, and the ratio of the average velocity of the two-phases is close to unity; that is, the flow is nearly homogeneous. Based on these indications, a homogeneous, partial-phase-change, sonic-velocity mechanism is proposed as an approximate explanation for the phenomenon of two-phase, one-component critical flow at low qualities. (auth)

49014 (BMwF-FBK-68-05) INFLUENCE OF THE GEOMETRY AND MATERIAL PROPERTIES OF THE HEATING SURFACE ON THE BOILING CRISIS IN FREE CONVECTION. Finck, D. (Technische Hochschule, Munich (West Germany). Institut fuer Technische Thermodynamik). Mar. 1968. 106p. (In German). Dep.

Previous equations and their derivations are compiled for the maximum heat flux (boiling crisis, burnout, or critical heat flux) with pool boiling in a saturated liquid. By examining approximately 700 previous measurements combined with nearly 2400 new test results for the maximum heat flux, distinct effects of the geometry and properties of the heating surface are disclosed. Interpretation of the phenomena was made difficult owing to the considerable scatter which occurred with repeated tests under otherwise identical conditions. The influence of some parameters is described by a model consisting of a heating element with a uniform spatial heat source distribution and local adiabatic surfaces. The behavior of the vapor bubbles adjacent to the heating element with various geometries at the maximum heat flux condition is described with the aid of photographs. (tr-auth)

49015 (FFA-115) ANOMALOUS HEAT TRANSFER AND PRESSURE DISTRIBUTIONS ON BLUNT BODIES AT HYPERSONIC SPEEDS IN THE PRESENCE OF AN IMPINGING SHOCK. Edney, Barry (Flygtekniska Forsoksanstalten, Stockholm (Sweden)). Feb. 1968. 92p. Dep.

An extraneous shock impinging on a blunt body in hypersonic flow has been found to alter the flow around the body and increase both the local heat transfer rate and pressure near the impingement point. Novel, quasi-static techniques were developed to study this phenomenon. Glass models, equipped with platinum thin-film thermometers, were injected into a hypersonic tunnel through a slot in a variable-incidence flat plate which generates the extraneous shock. Analogue networks provided graphs of the heat-transfer rates at various points on the model as a function of the model's position relative to the extraneous shock. Peaks in local heat transfer rates up to 10 times the local, unperturbed, free-stream values were recorded as the model traversed the shock. A similar technique was used to measure the peak pressure. The intense heating and high pressure were shown to occur over a narrow region where a disturbance, originating at the intersection of the bow shock and the impinging shock, meets the model surface. This disturbance may take the form of a free shear layer, a supersonic jet or a shock depending on the shape of the model and its position relative to the impinging shock. The exact form of this disturbance and the overall shock interference pattern may be predicted theoretically. Six different types of interference were shown to exist. The effect of varying the free-stream Mach number, the strength of the impinging shock and the ratio of specific heats on both the peak pressure and the peak heat transfer rate were also accounted for, in excellent agreement with experiment. (auth) (Swed)

49016 (LA-DC-9578) COMPUTER STUDIES OF TIME-DEPENDENT TURBULENT FLOWS. Hirt, C. W. (Los Alamos Scientific Lab., N. Mex.). [1968]. Contract W-7405-eng-36. 29p. (CONF-680817-1). Dep. CFSTI.

From International Symposium on High Speed Computing in Fluid Dynamics, Monterey, Calif.

Turbulence can be studied with existing computer technology. One aspect is the study of laminar instabilities, that is, the initial stages in the breakdown of a laminar flow into turbulence, and another is the gross effects of turbulence on a mean flow. Finite difference approximations introduce diffusion-like truncation errors that can obscure the effects of a real viscosity. These errors also influence the computational stability of numerical solutions. A thorough understanding of this point is necessary to avoid confusing numerical instabilities and physical instabilities. The Marker-and-Cell method for computing the dynamics of incompressible fluids with free surfaces is presented. If only the mean effects of turbulence on a flow are of interest, the difficulties in calculating high Reynolds number flows can be avoided. For in fully developed turbulence the effective turbulent viscosity is much larger than the molecular viscosity and thus, is not as likely to be obscured by finite difference errors. A method is described which enables the turbulence field itself to be determined. The turbulence is characterized by three field variables: a turbulence energy density, a turbulence viscosity, and a turbulence scale of size. A relationship is postulated among these variables, so that only two of them are independent. The two independent variables satisfy transport equations describing convection, creation, diffusion and decay processes. Extensions of these equations for anisotropic turbulence are then described, which, when coupled with mean flow Navier–Stokes equations, are applicable to a wide class of turbulent flows. Since these equations are highly nonlinear, numerical solutions are necessary to extract their full potential. In principle, it is not difficult to modify the Marker-and-Cell computing method to include the effects of turbulence transport, but early results indicate that implicit finite difference techniques will be necessary for efficient computer solutions. (auth)

49017 EXPERIMENTAL STUDIES OF HEAT TRANSMISSION IN A PILOT ISOTOPIC SEPARATION PLANT. Peculea, M. Rev. Chim. (Bucharest), 19: 394-6(July 1968). (In Rumanian).

All the parameters characteristic to the heat transfer process and to the temperature gradient in cross section were determined experimentally in an isotopic separation column. The separation was characterized by a complex process formed by the association of distillation with an exchange reaction. Due to the specific character of the phenomenon it was possible to obtain experimental data directly on a pilot installation independent of heat flows introduced. (auth)

49018 AN EFFICIENT ITERATIVE METHOD FOR THE GENERAL STATIC THERMOELASTIC SPHERE PROBLEM. Holy, Z. J. (Univ. of New South Wales, Kensington). Nucl. Eng. Design, 7: 503-16(1968).

An iterative perturbation method is developed for solution of temperatures and stresses due to variable heat transfer over the surface of a heat-producing sphere. An alternative matrix formulation of the method is obtained by direct series summation. Both formulations are applied to a number of heat transfer distributions and conclusions are drawn regarding their usefulness and efficiency. (auth)

49019 INFLUENCE OF AXIAL HEAT DIFFUSION IN LIQUID METAL-COOLED DUCTS WITH SPECIFIED HEAT FLUX. Burchill, W. E. (Univ. of Illinois, Urbana); Jones, B. G.; Stein, R. P. J. Heat Transfer, 90: 283-90(Aug. 1968).

An analysis was made of the temperature distribution and heat transfer in a generalized, symmetrical annular space including the effects of axial diffusion of heat in the fluid with the assumption of slug flow and with arbitrary heat-flux distributions at the walls of a section between two infinitely long adiabatic inlet and outlet sections. An examination was made of the effects produced by including axial diffusion and varying the Peclet number, the length of heated section, and the heat-flux distributions. The results may be applied to estimate the extent of the influence of axial diffusion and to correct predictions which have neglected it. (auth)

49020 INCIPIENT BOILING SUPERHEATS IN LIQUID METALS. Chen, J. C. (Brookhaven National Lab., Upton, N. Y.). J. Heat Transfer, 90: 303-12(Aug. 1968). (BNL-12040).

Measurements were obtained of the superheat required to initiate incipient boiling of potassium in forced convective flow.

Emphasis was placed on determining the effect of preboiling, deactivation conditions on subsequent incipient-boiling superheat. Data were obtained with deactivation subcoolings of 10 to 380°F, boiling temperatures of 1295 to 1600°F, and boiling pressures of 8 to 24 psia. Measured superheats ranged from 17 to 117°F. Sufficient data were obtained to indicate the functional dependence of incipient-boiling superheats on each of the three independent variables: deactivation pressure, deactivation temperature, and boiling pressure. The experimental results were found to be in substantial agreement with an analytical model developed herein. The proposed correlating equation was generally correct in predicting both the magnitude of the superheat and in its functional dependence on each of the independent variables. (auth)

49021 TRANSIENT POOL BOILING WITH EXPONENTIAL HEATING. Waters, J. D. Manchester, Eng., Univ. of Manchester, 1968. 117p.

Thesis.

Nucleation in boiling heat transfer is not completely understood, one of the reasons being the difficulty in defining local fluid temperatures close to a vapour bubble growing from a cavity in a heated wall. The investigation described chooses a particular set of circumstances which eliminates some of the uncertainties inherent in earlier work, and compares theoretical predictions with experimental results. The form of heating is such that the temperature at the surface of the test plate is increased exponentially with time. The relationship which is compared, experimentally and theoretically, is that between the time constant of the heating exponential and the most favourable cavity size for nucleation. This relationship is examined at various levels of subcooling. The experiments yielded some interesting data on the growth and collapse of a vapour film at a heated surface. This phenomenon is extremely important during a power transient in a water cooled nuclear reactor, when the heating is also increasing exponentially. Because of this important application, the growth and collapse of the vapour films are recorded and commented on, although the time constants in the experiments (30 to 600 sec) are very much longer than those experienced in a reactor power transient. (auth) (UK)

49022 ANALYSIS OF A VERY HIGH TEMPERATURE LIQUID ALLOY HEAT EXCHANGER FOR HYDROGEN. Peters, Edward T.; Kaufman, Larry (ManLabs Inc., Cambridge, Mass.). J. Spacecraft Rockets, 5: 1070-5(Sept. 1968).

Subject to constraints imposed by the requirements for a high-impulse, liquid-core nuclear engine, several liquid alloy systems have been analyzed as heat exchangers for hydrogen gas at 9000 and 10,000°R and 100-atm pressure. Assuming a regular solution liquid phase and an ideal gas vapor phase, a description has been developed for a ternary system to yield component vaporization, average molecular weight of vapor-hydrogen mixtures, alloy congruencies, rates of vaporization into vacuum, mass loss rates, and degradation to the specific impulse of hydrogen gas. Consideration has been given to the higher-order polymorphs of carbon vapor and to the formation of acetylene by carbon-hydrogen interactions. Calculations have been carried out for ternary alloys based on Me, C, and ^{235}U, where Me = Zr, Nb, or ^{184}W. None of the systems provided ternary congruencies; pseudocongruencies, however, could be obtained by seeding specified amounts of the faster vaporizing element(s) into the incoming gas stream. For a liquid pipe 4 in. in diameter by 10 ft long, with a stream velocity of 100 fps, mass loss to the gas stream is found to be rate controlling. For ^{184}W, the alloy vapors cause a 10% degradation to the specific impulse of pure hydrogen at 9000°R and a 30% degradation at 10,000°R. Somewhat larger degradations are obtained with the Nb and Zr containing systems. (auth)

Isotope Technology

Refer also to abstracts 48855, 48930, 48995, 49004, 49017, and 49785.

49023 (IS-1893) OPTIMIZING ACTIVITY SEPARATION IN FISSION PRODUCT DECAY CHAINS. Norman, J. H.; Talbert, W. L.; Roberts, D. M. (Ames Lab., Iowa). May 1968. Contract W-7405-eng-82. 80p. Dep. CFSTI.

A moving tape collector is described which was designed for the isobaric separation of activities for decay chains with isotopically pure parents. The moving tape collector is used to collect short-lived radioactivities in the ion beam of the TRISTAN isotope separator system. The Bateman equations were used to develop expressions for the buildup and decay of activities present in the deposited isotope separator beam. A computer program is presented that can be used to calculate the activity of each decay chain member and the activity ratio of the member of interest to the total activity present as a function of beam deposit time, decay time prior to counting, and count time. An optimization scheme is described that can be used to select the beam deposit time and decay time for the maximum activity separation of each member of the decay chain. The results of the optimization are presented for each decay chain which is produced by the present configuration of the TRISTAN system, i.e., the chains whose parent nuclides are the noble gases ^{89}Kr to ^{95}Kr and ^{139}Xe to ^{143}Xe. The physical characteristics of the moving tape collector were measured and results are presented which demonstrate the accuracy possible in positioning the tape and the effectiveness of the internal shielding between detector positions along the tape. Results of the use of the moving tape collector and the optimization techniques applied to the separation of ^{92}Kr and ^{92}Rb in the ^{92}Kr decay chain are presented. (auth)

49024 (MLM-1495) STABLE GASEOUS ISOTOPE SEPARATION AND PURIFICATION: JANUARY-MARCH 1968. (Mound Lab., Miamisburg, Ohio). Sept. 30, 1968. Contract AT-33-1-Gen-53. 45p. Dep. CFSTI.

Progress is reported on separation methods for C, He, Ne, Ar, Kr, and Xe isotopes; on thermal-diffusion research; and on low-temperature research. (M.C.G.)

49025 (N-68-25283) ISOTOPE REENTRY VEHICLE DESIGN STUDY: CONCEPTUAL DESIGN, PHASE 1A. Topical Report. (Avco Corp., Lowell, Mass. Avco Space Systems Div.). May 1968. Contract NAS3-10938. 528p. (NASA-CR-72366; AVSSD-0071-68-CR). CFSTI.

The Phase IA conceptual design effort on the Isotope Reentry Vehicle (IRV) study is summarized. The major objective of the study is to develop a preliminary design of a 25 kW; Pu 238 IRV. Major design emphasis is on system safety and developability. The IRV is configured to meet minimum practical diameter and weight limits. During Phase IA various IRV, heat source, and heat-source heat exchanger concept combinations have been developed and evaluated. Three IRV systems have been recommended for detailed conceptual design evaluation in Phase IB. (auth) (STAR)

49026 (NUS-301(Vol.1)) RADIOLOGICAL CONTROL PROCEDURES APPLICABLE TO RADIOISOTOPE THERMOELECTRIC GENERATOR SNAP-27. VOLUME 1, NORMAL OPERATIONS. Garcia, Luis F.; Calley, Harry W. (NUS Corp., Washington, D. C.). Sept. 12, 1966. 59p. Dep. CFSTI.

The radiological control procedures applicable to the normal transport, handling, and storage of the radioisotope thermoelectric generator (SNAP-27), prior to launching, are discussed. Procedures and standards, based on standards of the AEC and other regulatory agencies, are established for permissible doses, levels, and concentrations, classification and posting of storage areas, instruction of personnel, monitoring of storage areas and personnel, and precautions and regulations relating to the off-site transport of radioactive materials. The procedures and standards relate only to routine handling by the SNAP-27 custodial staff. (E.R.B.)

49027 (NUS-301(Vol.2)) RADIOLOGICAL CONTROL PROCEDURES APPLICABLE TO RADIOISOTOPE THERMOELECTRIC GENERATOR SNAP-27. VOLUME II, RADIOLOGICAL EMERGENCIES. Garcia, Luis F.; Calley, Harry W. (NUS Corp., Washington, D. C.). Sept. 30, 1966. 68p. Dep. CFSTI.

Emergency procedures applicable to potential radiological accidents that may occur during handling, storage, and transport of the radioisotope thermonuclear generator (SNAP-27), prior to launching, are discussed. Procedures and limits, based on standards of applicable regulatory agencies, are established for peacetime emergencies including external and internal exposure of personnel and the general population; ^{238}Pu contamination guides; guidelines for preplanning responses to emergency situations by management, health physics groups, and medical groups; emergency equipment; and practice drills. Criteria for determining the existence of an accident and action to take during handling and storage, alarm systems, scram rules, and evacuation procedures are also discussed. Criteria and action, including notification of proper civil and government authorities and news media in the event of an accident during transport is discussed along with the procedure for detection and recovery of lost capsules. Sources of assistance during a radiological emergency are given as are the post-emergency functions to be followed including follow-up biomedical functions and the keeping of proper and adequate records of the accident. (E.R.B.)

49028 HOW TO GET A LICENSE TO USE RADIOISOTOPES. Washington, D. C., Atomic Energy Commission, 1967. 38p. $0.30. GPO.

The regulations and safety standards are outlined for state and AEC. The procedures are given for obtaining a license for use of radioisotopes which include preparing applications and all aspects involved. (J.C.W.)

49029 REQUIREMENTS FOR A PACEMAKER USING AN ATOMIC ENERGY SOURCE. Evalenko, George A. (Hycon Manufacturing Co., Monrovia, Calif.). pp 281-5 of Progress in Biomedical Engineering. Fogel, Lawrence J.; George, Frederick W. (eds.). New York, Spartan Books, 1967.

From Symposium on Biomedical Engineering, San Diego, Calif., June 20-22, 1966. See CONF-660660.

The requirements for an implantable cardiac pacemaker using ^{238}Pu as the long-lived power source are discussed. It is pointed out that in addition to high reliability and long life the requirements for proper failure mode and fail-safe characteristics must be added. (C.H.)

49030 ON THE USE OF RADIOACTIVE TRACERS IN DIFFUSION EXPERIMENTS. Mokady, R. S.; Zaslavsky, D. (Israel Inst. of Tech., Haifa). Soil Sci. Soc. Amer., Proc., 31: 604-8 (Sept.-Oct. 1967).

A theoretical analysis was made of the limitations in the application of radioisotopes in soil diffusion experiments, either as tracers or in self diffusion experiments. Limitations of the tracer technique of 2 types are examined. The first is due to different modes of adsorption or immobilization of the tracers and the carrier. In the course of their movement in soils, by convection or diffusion, many ionic and molecular species react with the soil. Thus, the flow is not a simple process but rather involves sources and sinks. These sources and sinks may be different for the carrier and the tracer. In such cases the tracer may not be a simple representative of the carrier. The second type of limitations refers to the similitude between the flows of the tracer and the carrier when the decay is conventionally corrected. In using an isotopic tracer, perfect analogy to the carrier is obtained when the differential equation and the boundary conditions become analogous for the flows of both the tracer and the carrier, once the correction for the decay is used. The resemblance of the 2 flows is discussed for the case of stable and radiophosphorus diffusion in soils with sinks. (BBB)

49031 HOW RADIOACTIVE PISTON RINGS MEASURE ENGINE WEAR. Stephanson, B. T. (Univ. of Alberta, Edmonton). Agr. Eng., 46: 554-7; 569 (Oct. 1965).

The technique described consists of measuring the amount of radioactive Fe in the lubricating oil under various test conditions. The radioactivity can be measured in oil samples withdrawn from the crankcase at time intervals and the oil then returned to the system or circulated continuously around a detector. The circulation procedure uses a ratemeter which permits counting only while the oil is passing through the detector and allows observation of changes occurring in short intervals. The radioactivity is recorded as a curve of cycles per minute against time. The slope of this curve is proportional to the ring wear rate. Most tests have used a radioactive top ring on the piston. The second ring groove gives better precision in wear measurement. Wear is erratic in the top groove. A different technique allows determination of the rotation of the piston ring in its groove. The iron ring is prepared with a small piece of cobalt encapsulated in the back face. The ratio of face to side wear of the ring can also be determined. Preparation of rings and safety considerations are discussed. (BBB)

49032 VALUES IN SPENT FUEL FROM POWER REACTORS. Rohrmann, C. A. (Battelle-Northwest, Richland, Wash.). Isotop. Radiat. Technol., 6: 19-41 (Fall 1968).

A study was made to appraise the magnitude of future amounts of by-products available from discharged reactor fuels, to consider the possible candidate materials that are most likely to have value, to utilize some simplified ground rules for appraising value and recovery cost, and to estimate in a preliminary way the value of candidate materials in unprocessed fuels. The candidate by-products from reactor fuels are considered in three groups: (1) fission products, both radioactive and stable; (2) the higher isotopes, i.e., ^{236}U, ^{237}Np, and isotopes of americium and curium; and (3) the plutonium isotopes. Although the reactor operator may expect only modest credit from fission products at the level of credit for absorbed neutrons utilized in this study, very high returns to the fuel owner or reactor operator are indicated for the other two groups, which could significantly lower the cost of power. This credit appears so large for certain products formed by neutron absorption that a critical analysis of the value of neutrons and the value of products is suggested. Continued laboratory-scale investigation of integrated processes for fuel and isotope processing is recommended, with emphasis on the technology of americium, curium, the noble metals, and the rare gases. Credit for the fissionable plutonium isotopes at the published $10/g figure assures the soundness of the economics of fuel processing. (auth)

49033 ISOTOPIC POWER IN EUROPE. II. Morse, Jerome G. (Martin Marietta Corp., Denver). Isotop. Radiat. Technol., 6: 100-8 (Fall 1968).

An increase in active isotopic power source programs in Europe from 17 to 27 in one year is indicative of growing interest. Comments are made on specific national and international programs, on future growth, and on terrestrial and space safety. (auth)

49034 LEAK DETECTION WITH RADIOISOTOPE TRACERS. Gerrard, Martha. Isotop. Radiat. Technol., 6: 44-57 (Fall 1968).

The literature (approximately 100 references) on the use of radioisotope tracers for detecting leaks in buried pipes and cable sheaths, cross-stream units such as heat exchangers and automatic transmission systems, vehicles, water carrier and storage systems, hermetically sealed components, and miscellaneous units and systems is reviewed. (auth)

49035 RADIOISOTOPE SURVEY IN FRANCE. Benchetrit, D.; Cohen, H. Bull. Inform. Sci. Tech. (Paris), No. 128, 51-68 (July 1968). (In French).

The survey on radioisotope applications made in 1962 was updated in 1967. Its purpose was to give data on the evolution of the main uses of radiation in industry. It is shown that the number of gaging instruments has increased markedly and that forecasts for the coming years give the same trend. Likewise nondestructive testing with radioisotopes is developing steadily. Other areas like ionization, tracer applications and irradiation show a slower evolution but the small number of users limits the statistical meaning of the results. As a whole, a 75% increase in radioisotope uses was noted for the period 1961 to 1966. Data concerning the market for the years 1968 to 1970 are given. (auth)

49036 ALPHA PARTICLE EXCITED MONOCHROMATIC X-RAY SOURCE. Sellers, Francis B. (to Parametrics, Inc.). U. S. Patent 3,383,510. May 14, 1968. Filed Dec. 7, 1964.

A substantially monochromatic x-ray source design is given in which an alpha particle emitter is used to bombard a target material to produce x-rays characteristic of the target material. A narrow band filter is used to further narrow the spectrum of x-rays produced. The filter, target and alpha emitter are arranged on a base so that only the characteristic x-rays from the target are allowed to strike the filter. (auth)

49037 GEOMETRY CALCULATION AND FLUX MEASUREMENT FOR THE FAST NEUTRON IRRADIATION WITH AN ACCELERATOR. Shinomiya, Chiro; Kishikawa, Toshiaki (Kumamoto Univ., Japan). Kumamoto Daigaku Kogakubu Kenkyu Hokoku, 16: No. 3, 68-74 (Jan. 1968). (In Japanese).

When irradiating samples on a rotating base directly below the neutron source, the circular or square samples being arranged in a circle, the neutron flux at the position of samples can be represented by the distance relation of neutron source and sample. This relation was obtained as a function of source-sample base distance and of rotating axis-sample distance. Calculations are made for some cases, and are compared with the measured values by the activation technique. When expressed as functions of h/a, d/a or h/a, b/a, they are applicable for samples of any given size. If the distance of source and sample is sufficiently large, it is possible to approximate as an isotropic, point source. Under the given deviation from the rotation axis, the axial distance with a maximum neutron flux is observed. (NSA of Japan)

49038 LABORATORY EVALUATION OF SELECTED RADIOISOTOPES AS GROUNDWATER TRACERS. Jennings, A. Ray; Schroeder, Melvin C. (Texas A and M Univ., College Station). Water Resour. Res., 4: 829-38 (Aug. 1968).

Choice of radioisotopes for following ground-water flow is discussed. The radioisotopes used should be either in anionic or nonionic form, as cations are most susceptible to ion exchange. The choice of anionic radioisotopes for ground-water tracers is limited because of the half-life, type, and energy of the radiation emitted, and in some cases the chemical complexity of the isotope. A suitable detection time for radioisotopic tracers is from 3 to 5 half-lives. As the appearance of a tracer results from movement along the most direct flow path, the arrival of the maximum concentration is the best index for determining the average water velocity. Antimony-121, ^{141}Ce, ^{51}Cr, ^{114}In, ^{103}Ru, and ^{85}Sr in chelate form were tested, as the unchelated ions are subject to greater delay by adsorption and ion exchange. Distribution-coefficient measurements were made under static conditions for crushed illitic shale and limestone, and these measurements used to predict the elution history of a tracer from an exchange column. Comparisons of the predictions, the tracer

elution histories, and elution histories for chloride pulses indicated chelated ^{51}Cr to be a useful ground-water tracer. (BBB)

49039 SOVIET GAMMA APPARATUS FOR RADIATION INVESTIGATIONS IN BIOLOGY AND MEDICINE. Zhukov, B. G.; Kaushanskii, D. A.; Averkiev, V. P. Med. Radiol., 13: No. 7, 47-52(July 1968). (In Russian).

The main types of Soviet isotope gamma sources intended for experimental research in the field of biology and medicine are described. Brief technical parameters of ^{137}Cs and ^{60}Co sources are included and the fields of their use discussed. (auth) (TSS)

49040 RADIOISOTOPES IN THE STEEL INDUSTRY. Booth, E. (Australian Iron and Steel Pty. Ltd., Port Kembla, New South Wales). At. Energ. Aust., 11: No. 3, 9-12(July 1968).

The present and potential uses of nuclear methods in the steel industry are discussed by considering the step-by-step production of steel. Examples are given of radiometric methods used in ironmaking for on-stream analysis of raw material flow, for determining the composition of the sinter, for tracing the flow of materials through the blast furnace, and for studying erosion in the refractory lining of the furnace. Radioisotopes have been used extensively in studies to improve the open hearth steel making process. Examples are: ^{131}Ba, ^{45}Ca, and ^{140}La for slag formation studies, ^{45}Ca, ^{140}La, and ^{32}P for determining slag weight; ^{59}Fe for measuring rate of scrap melting; and ^{32}P and ^{35}S for investigating the pickup and removal of P and S in steel. Numerous other isotopes are listed for particular applications. Radiometric methods for gaging finished steel products, such as tin plate, are discussed. It is concluded that the economic potential of nuclear techniques will increase their uses in the steel industry. (L.C.L.)

49041 MEANS FOR CONTROLLING CALUTRON FILAMENT ACTIVATION. Williams, C. (to United States Atomic Energy Commission). U. S. Patent 3,406,283. Oct. 15, 1968.

A calutron for the separation of isotopes of alkaline earths, the rare earths and certain other elements is described. The calutron has a source of gas and means for feeding this gas at a controlled rate into the region near the calutron ion source filament to prevent filament activation normally caused by the calutron charge vapor. The calutron arc discharge is better stabilized and the purity of the collected isotopes is substantially improved. The feed gas is selected from the group consisting of CS_2, S_2Cl_2, H_2S, and CCl_4. (AEC)

Materials Testing

Refer also to abstracts 48978, 48982, 49150, 49717, and 50735.

49042 EXPERIMENTAL NEUTRON RADIOGRAPHIC SCATTER FACTORS. Kraska, I. R.; Berger, Harold (Argonne National Lab., Ill.). Mater. Eval., 26: 187-90(Sept. 1968).

Experimental neutron scatter data for a reactor neutron beam have been obtained for steel, natural uranium and lead samples of various thicknesses. The observed data compare well with those of other investigators for small sample thicknesses. Most significant is the fact that these data have been obtained for sample thicknesses greater than those previously reported, and that a peaking of scatter factor results has been observed for all three inspection materials at large thicknesses. The scatter factor peaks have been experimentally observed with a BF_3 counter and with indium foil activation detectors (bare and cadmium covered). Radiographic studies also confirm this effect for transfer neutron radiographs taken with indium and dysprosium foils. Contrast sensitivity degradation can be radiographically observed for samples at or near the peak scatter factor thickness. This degradation is most pronounced for steel at a thickness of 3.5 in.; at this point the scatter factor reaches a value of 28 and the observed transfer method contrast sensitivity is in the range of 7 percent. Lesser effects are observed for natural uranium and lead, both of which exhibit peak scatter factors in the range of 4 to 5. (auth)

49043 REVIEW ON THE RADIATION PENETRATION TESTS IN 1966. Senda, Tomio (Osaka Univ.). Hihaki Kensa, 16: 431-2(Oct, 1967). (In Japanese).

A review is made on the state of radiation penetration tests for the period of January to December 1966. X-ray devices of about 200 kVp are most widely used, while γ-rays are employed relatively little. Also, with increasing size of the welded structures, accelerators of 5 to 25 MeV came to be used. X-ray film characteristic curves, the problems of scattered X-rays, blackening, and stereoscopic photography were investigated. Considerations of the radiation testing standards were made. Testing of the welds was automatically achieved, the welds in rails and the welds in chemical reactors were performed. (NSA of Japan)

49044 USE IN INDUSTRY OF ELASTICITY MEASUREMENTS IN METALS WITH THE HELP OF MECHANICAL VIBRATIONS. Bradfield, G. Notes on Applied Science No. 30. London, Her Majesty's Stationery Office, 1964. 170p. 10s. 0d. (NP-17477).

Equipment and procedures, using mechanical vibrations, to determine the values of elastic constants for metals and nonmetals are reviewed. Methods discussed include resonance, pulse methods using high frequencies, use of surface waves in the ultrasonic goniometer, and the frequency modulation or frequency scanning method. Tables list corrections necessary for determining true velocity from the apparent velocity. Eighty-eight references. (P.G.C.)

49045 ADVANTAGES OF EPICADMIUM NEUTRON BEAMS IN NEUTRON RADIOGRAPHY. Spowart, A. R. (United Kingdom Atomic Energy Authority, Caithness, Scotland). Non-Destruct. Test., 1: 151-5(Feb. 1968).

Epicadmium neutron radiography has been developed as a complementary ndt technique to thermal neutron radiography and x-radiography. Increased penetration is obtained in suitable materials, particularly the enriched uranium and plutonium based nuclear fuels. One of the detection methods, the transfer technique, is completely insensitive to gamma rays and therefore extremely useful in post-irradiation examination of highly active materials. (auth)

Protective Structures

49046 FALLOUT SHELTER. Overhill, T. D. Eng. J. (Montreal), 50: 7-10(Sept, 1967).

The Canada Emergency Measures Organization has estimated that up to 93% of the population of Canada would survive a nuclear attack on North America if fallout shelters were available to all. Investigations of possible attack patterns and the effect of varying patterns on the casualty rate in different types of shelters are continuing because of technological advances which, among other factors, can be expected to alter primary conclusions. Design features of fallout shelters are outlined. All factors that relate to the survival of an individual are considered, and every effort made to give equal weight to all critical ones. The obvious need for radiation protection should not take precedence over equally vital survival needs, such as tolerable temperatures, proper consumable supplies, and adequate waste disposal. Even shelters that are able to provide protection for 48 hr, the length of time required for fallout to settle and radiation levels to be mapped, will ensure the survival of large groups who would otherwise perish. (BBB)

Radioactive Material Handling

Refer also to abstracts 48989–48991, 48993, and 49152.

49047 (ORNL-TM-2178) STRUCTURAL ANALYSIS OF THE BROOKHAVEN NATIONAL LABORATORY MOBILE GAMMA IRRADIATOR. Evans, J. H. (Oak Ridge National Lab., Tenn.). Sept. 1968. Contract W-7405-eng-26. 62p. Dep. CFSTI.

The methods of evaluating the structural integrity of a container in which radioactive material is shipped to show compliance with the governing regulations are illustrated. The structural analysis performed on the Brookhaven National Laboratory Mobile Gamma Irradiator is described. Calculatory procedures and operating experience were applied in the analysis of the cask with respect to the regulations governing the general standards for packaging, the structural requirements, the normal conditions of transport, and the specified hypothetical accident conditions. Structural modifications were proposed to eliminate deficiencies in the existing cask, and this analysis demonstrated that with the proposed cask lifting devices, crash frame, and puncture apron, the irradiator complies with all the applicable regulations. (auth)

49048 (SERL-67-10) GAS DISPERSION IN POROUS MEDIA. PECLET-REYNOLDS NUMBER CORRELATIONS. Bolch, W. Emmett; Selleck, Robert E.; Kaufman, Warren J. (California Univ., Berkeley. Sanitary Engineering Research Lab.). Nov. 1967. Contract AT(11-1)-34. 134p. Dep. CFSTI.

The theoretical prediction of the transport of radioactive trace gases through natural porous materials is a basic consideration in the engineering design of ground injection systems proposed as accessory facilities to containment structures for nuclear power plants. Studies of longitudinal dispersion in porous materials have applicability and value to a wide range of engineering and scientific processes. A mathematical model analogous to molecular diffusion was developed for the prediction of transport of a trace pulse injected into a carrier gas flowing through 16-foot long, 2-inch diameter columns containing various granular media of

definable characteristics. Longitudinal dispersion coefficients determined from the breakthrough peaks were correlated in terms of a Peclet–Reynolds–Schmidt number system. Any given mode was investigated over a range of Reynolds numbers sufficient to describe the entire laminar region. The influence of changes in the Schmidt number, tortuosity, particle-to-column diameter ratio, particle shape, uniformity coefficient, and porosity upon longitudinal dispersion was identified for each parameter and quantitatively demonstrated. An expression was developed which accommodates these major parameters and describes the phenomena of longitudinal dispersion in the laminar region. Considerable research effort and theoretical analysis was given to the concept of tortuosity. A highly uniform, horizontally stratified, microplate medium provided a comparison of a mathematical model with an experimental value. Molecular diffusion coefficients for the radioactive tracer-carrier gas binary system were determined experimentally and compared to calculated values. (auth)

49049 SHIPPING CONTAINERS FOR IRRADIATED REACTOR FUELS. Rollins, Jack D.; Lusk, Elmer C. (Battelle Memorial Inst., Columbus, Ohio). Battelle Tech. Rev., 17: 9-15(Aug. 1968).

The design requirements of shipping containers for irradiated fuel are considered, and the characteristics of shipping containers, such as shape, size, and material composition, that fulfill these requirements are discussed. A major problem with lead shields is the maintaining of sufficient shielding over the entire surface of the container in the event of a "standard fire" as defined in the AEC regulations. Lead melts at 620°F, a temperature frequently exceeded under the conditions designated for a standard fire. Provision must be made for an expansion of more than 3% in the volume of lead in case it melts. Upon resolidification and shrinkage of the lead, a void will be created in the shielding at the most vulnerable spot with respect to radiation shielding. Other shielding materials, such as tungsten, iron, and depleted uranium, have been used in shipping containers. However, these materials, though having higher melting points (i.e., better fire resistance) and greater structural strength, are not at present economically competitive with lead and, therefore, are not used extensively. In addition to providing subcriticality, designers must consider the possible interaction of the container with others containing fissile material. Where large containers, such as those used for multielement shipments of irradiated fuel are utilized, the fuel is essentially isolated by the thickness of the reflective material (lead, steel, etc.), and this requirement usually does not affect the design of the container. The fuel element basket used in multielement shipments is normally constructed of a material such as copper that has high thermal conductivity and can, therefore, effectively dissipate heat in the absence of the water coolant. The web sections of the fuel element basket are typically 0.25 to 0.75 in. thick and may or may not be attached to the inner cask wall. As the fuel element capacity of the container is increased, the shipping costs per pound of fuel decrease. However, if a longer decay time is required to accommodate the fuel to the container, inventory charges may offset any savings made by a larger shipment of fuel elements. In any case, containers that can handle the maximum quantity of decay heat are most advantageous. (BBB)

49050 CONTAINER FOR A DAMAGED FUEL. Komizu, Toshiaki (to Hitachi Ltd.). Japanese Patent 1967-22874. Dec. 25, 1967. Filed Dec. 1, 1964.

In the container proposed, the radioactive gas, released from a damaged fuel, can be completely contained, and the increase in internal pressure due to the fuel decay heat can be absorbed internally; the container itself is transportable by means of a hook at the lid. The massive lid is divided into two parts: the outer mass and inner mass, both being inserted into the open end of the container. An internal–pressure absorbing device is installed on the inside of the inner mass. After insertion of the inner mass, the outer mass is inserted; a small protrusion from the mass engages with the groove cut on the inside of the container body. A spring device is used between the outer and the inner mass to press them in both directions, leading to the tight sealing of the damaged fuel container. (NSA of Japan)

49051 OPENER FOR A CAPSULE SEALED IN A USUAL CANNING WAY. Osugi, Minoru (to Japan Atomic Energy Research Inst.). Japanese Patent 1968-7279. Apr. 1, 1968. Filed Mar. 30, 1964.

By the method proposed, the lid of a capsule, sealed in a usual way, can be opened in the hot cell, with a ball-socket manipulator. It is essentially a bottle opener. The opener is fixed at the end of a manipulator rod, at the base of the opener. After placing the opener properly on the lid of a capsule, the forward force applied to the base pries the lid open. The manipulator rod is divided into two sections, and also the rod-guiding pipe. The opener itself, when not used, is forced into a horizontal position, by means of a spring, which is set within the part of guide tube next to the opener base. (NSA of Japan)

49052 OPENER FOR A CAPSULE SEALED IN A USUAL CANNING WAY. Osugi, Minoru (to Japan Atomic Energy Research Inst.). Japanese Patent 1968-7278. Apr. 1, 1968. Filed Mar. 9, 1964.

The opener proposed can be easily handled in a hot cell by a manipulator, to open the lid of a capsule sealed in the usual way. It is essentially a bottle opener mechanism. A two-pronged member is fixed at the base of the opener with bolt and nut; the member has a rising slope with respect to the opener. The two tongs of a manipulator are inserted into respective hollow prongs. Then, after placing the opener on the lid of a capsule properly, the force toward the capsule is applied, to pry the lid open. (NSA of Japan)

49053 GRAB-MANIPULATION ROD FOR RADIOACTIVE MATERIAL. Mikami, Takao (to Tokyo Shibaura Electric Co., Ltd.). Japanese Patent 1967-22878. Dec. 25, 1967. Filed July 15, 1964.

The grab-manipulation rod proposed is used for moving a radioactive material in a reactor or processing facility. In the rod, the grab arms at its end are opened when rotation is applied at the operating end. Otherwise the arms are always forced to close by a spring. The grab consists of the following parts: the long manipulating-rod, with the grab arms fixed at one end and the operation handle at the other end; a wire running through the rod, which opens the grab arms against the force of a spring; the grab arms which are installed at right angles to the rod (one arm is fixed and the other arm partly rotatable); and, the spring, which operates the grab arms as described. (NSA of Japan)

49054 HOLLOW ROD FOR A MANIPULATOR TONG PASSING THROUGH A SHIELDING WALL. Hayashi, Katsuhiko (to Japan Atomic Energy Research Inst.). Japanese Patent 1968-3599. Feb. 14, 1968. Filed June 19, 1964.

By the method proposed, the manipulator-tong hollow rod can be extended readily, and it can pass through the shielding wall smoothly. It consists of two sections: the rod proper at the end of which the claws are fixed, and the extension rod. At the joining ends of the two rods, cuts are made so that the protrusions of one rod engage in the cuts of the other rod. A removable band tightly fastens the joined ends of the two rods. (NSA of Japan)

49055 DEVICE FOR ROTATING THE CLAWS OF A RADIOACTIVE MATERIAL HANDLING TONG. Hayashi, Katsuhiko (to Japan Atomic Energy Research Inst.). Japanese Patent 1967-22879. Dec. 25, 1967. Filed Aug. 27, 1964.

By the method proposed, the claws of a tong can be rotated with the grip being in its normal position; the operation of handling can be done easily with one hand. The procedure is as follows: splines are cut at the grip end of a hollow rod (the claws are installed at the other end); ratchets, for the rotation of the claws to the right and left, are installed to engage and disengage with the splines by sliding; a control lever for the ratchets and splines is installed near the grip. (NSA of Japan)

49056 GRIP-SLIDE TYPE TONGS FOR A RADIOACTIVE MATERIAL HANDLING MANIPULATOR. Hayashi, Katsuhiko (to Japan Atomic Energy Research Inst.). Japanese Patent 1967-22880. Dec. 25, 1967. Filed Sept. 15, 1964.

In ordinary, commercially available tong-manipulators, the grip can freely slide with respect to the spindle. By the method proposed, such tong-manipulators can be operated simply and positively at any operator's position. The procedure of operation is as follows: the grip can slide along the outside of the long, hollow spindle, in the axial direction; a rotatable wheel is installed on the grip, and a wound spring is set in the wheel, its inner end being fixed to the axle of the wheel; and the other end of the spring extends through the spindle to the claws at the end of the spindle. (NSA of Japan)

49057 MECHANISM FOR HANGING A RADIOACTIVE MATERIAL CONTAINER IN A STORAGE HOLE. Utsunomiya, Takeshi (to Kimura Lead and Iron Chemical Machinery Co., Ltd.). Japanese Patent 1968-7280. Apr. 1, 1968. Filed Apr. 9, 1965.

The mechanism proposed has the advantages of safe and easy remote operation. It consists of the following: a bottom shield at the bottom of which a hollow is formed for housing the claws to catch a radioactive-material container; a sliding shield, located just above the bottom shield; the lid for the chamber, containing the two shields; a large sliding bar running axially through the chamber. At the top of the bar a means is provided for hanging the chamber and, a means, which permits the claws to catch a radioactive-material container when the chamber hits the container. (NSA of Japan)

49058 DEVICE FOR SECURELY HOOKING THE LID OF A RADIATION SHIELDED CONTAINER. Imai, Hisaichi (to Chiyoda Safety Appliance Co., Ltd.). Japanese Patent 1967-22877. Dec. 25, 1967. Filed Sept. 21, 1964.

By the method proposed, a transport container can be fixed in position above a radiation-shielded container so as not to move when the lid of the latter container is opened. A base is placed on the shielded container. The base has a large through hole which is aligned with the opening of the shielded container. Within the base, the lid to the container slides horizontally, so as to close or open the containing space. This lid is hooked by a protrusion within the base, when it is closed. At the outside edge of the base, a means is provided for fixing a transport container placed on the base. (NSA of Japan)

49059 NUCLEAR FUSION PRESENTS NEW PROBLEMS. Malleroy, Antoine. Atomes (Paris), 23: 248-50(Apr. 1968). (In French).

The principal laboratory problem in the development of the fusion process remains the confinement of hot plasmas. Laboratories at Los Alamos, Culham, and Fontenay-aux-Roses recognize this problem must be solved before controlled fusion can be foreseen. At Culham a project on a 2100-MW thermonuclear plant is under study, and Oak Ridge has published the first warning against fusion radioactive wastes. Until this time, radioactive wastes have not been greatly studied for fusion reactions. More than 15% of the amount of tritium produced in fusion may be lost; a 1000-MW plant could release 10^6 Ci of activity each day. Waste materials would be 10^4 higher in a fusion plant than in a fission plant. Perhaps the greatest part of this 15% would not be lost but put back into circulation, another fraction absorbed by reactor materials, and some lost by radioactive decay. Consequently, great precautions will have to be taken to avoid a general contamination of the planet if controlled nuclear fusion becomes an achievable phenomenon. (BBB)

49060 HOT CELLS FOR A TRANSPLUTONIUM PROGRAM IN KARLSRUHE. Boehme, G.; Eberle, S. H. (Kernforschungszentrum, Karlsruhe, Ger.). Atomwirt., Atomtech., 13: 433-35 (Aug.-Sept. 1968). (In German).

A transplutonium program is planned whose first aim is the irradiation of 1 kg of plutonium and the extraction and investigation of milligram quantities of californium. A special alpha-gamma chemistry cell installation is planned. It has the following tasks: reprocessing of irradiated plutonium, encapsulation of strongly radiating radionuclides such as ^{243}Am or ^{244}Cm, isolation of the products from the high flux irradiation and the carrying out of experiments with californium and curium in milligram or gram amounts. The special requirements of the plant include sufficient shielding, pipelines, and vessels that will withstand the irradiation and the necessary corrosive chloridic solutions, safe-functioning remote control techniques because of the expected frequent changes of the equipment in the cells and accessibility of the inner rooms after decontamination. The equipment cannot be installed as fixtures in the cells. Rather it must be possible to assemble and test it in a working state outside the cells for each experiment, then to install it in the cells and finally, after completion of the work, to remove, it as a whole from the cells through locks. (auth)

49061 IMPROVEMENTS IN THE STORAGE OF RADIOACTIVE LIQUID EFFLUENT. Corbet, Alan Denys Wellington; Higginson, Walter (to United Kingdom Atomic Energy Authority). British Patent 1,129,342. Oct. 2, 1968. Filed Aug. 20, 1965.

A method is presented of concentrating and storing radioactive liquids. The containment vessel is under subatmospheric pressure so as to cause low temperature boiling by heat derived from the decay of radioactivity. The resultant vapor is condensed and the condensate returned to the vessel. (J.C.W.)

49062 TEST OF RADIOISOTOPE SHIPPING CONTAINER. At. Energy Aust., 11: No. 3, 32-3(July 1968).

A container for shipping highly radioactive isotopes, such as ^{60}Co, and consisting of a 3 ton lead and steel inner section and a $1\frac{1}{2}$ ton steel and timber crate, was subjected to a series of tests to determine its ability to withstand accidents. Six photographs are presented to show the condition of the container during and following drop tests, and pressure and fire tests. (L.C.L.)

49063 REMOTE-CONTROLLED POSITIONING APPARATUS. Loriot, Pierre; Mas, Roland (to Commissariat a l'Energie Atomique). British Patent 1,125,909. Sept. 5, 1968. Priority date Dec. 10, 1964, France.

An apparatus is described which is used to position a moving body such as a girder of an overhead crane in a hot cell by remote control. The apparatus which makes the moving body more responsive by insuring accurate positioning consists of two motors, two switches or a relay, and two cams. The two motors drive the body in opposite direction. The switches, mounted in parallel, energize the motors and the cams control the switches. (F.S.)

49064 SAMPLE HANDLING AND RADIATION DETECTING DEVICE. Meinig, I. Karl-Heinz. British Patent 1,128,460. Sept. 25, 1968. Priority date Jan. 5, 1965, Germany.

A sample handling device is described which automatically transports radioactive samples in test tubes and places the sample in the hole of a scintillation crystal for counting. (W.H.K.)

Vacuum Engineering

Refer also to abstract 48979.

49065 EVOLUTION OF THE MEASUREMENT OF TOTAL PRESSURES FROM SEVERAL TORRS TO 10^{-13} TORR. Deterck, Henry (Societe Generale du Vide, Choisy-le-Roi, France). Ind. At., 12: No. 7-8, 39-50(1968). (In French).

Following a review of the principles of the kinetic theory of gases to bring out the inadequacy of the conception of "pressure" as being force in making measurements of very low or relatively low pressures, consideration is given to classifying manometers into six main categories. In each instance the range of pressures that can be measured is specified, along with the precision and the developmental possibilities modern measuring equipment is then set forth. This falls into two broad categories: calibration manometers, manometers for checking and measuring. Measurements of pressures lower than 10^{-10} torr are discussed in connection with a detailed study of hot cathode ionization manometers. (auth)

INSTRUMENTATION

Radiation Detection Instruments

General Detectors and Monitors

Refer also to abstracts 49098, 49168, 49325, 49399, 49417, and 49418.

49066 (AERE-R-5800) THE R.C. 13 IONISATION CHAMBER. Mackie, J. F. (Atomic Energy Research Establishment, Harwell (England)). June 1968. 20p. Dep. CFSTI. UK 3s. 6d.

The R.C. 13 ionization chamber was developed for use in reactor control and instrumentation for the measurement of thermal-neutron flux. It requires a polarizing voltage of 300 to 600 volts, and will deliver up to 50 μA in fluxes up to 10^{10}n/cm²s at normal temperature and pressure. The small diameter reduces installation, handling, and maintenance problems. The chamber and its characteristics are described, together with experience in use in the DIDO reactor. (auth)

49067 (ANL-7394) ANALYSIS AND REDUCTION OF PROTON-RECOIL DATA. Bennett, E. F.; Gold, R.; Olson, I. K. (Argonne National Lab., Ill.). Jan. 1968. Contract W-31-109-eng-38. 130p. Dep. CFSTI.

A process for reducing 4π proton-recoil proportional-counter pulse-height distributions to fast-neutron energy spectra is described. Required corrections, including those associated with finite detector size, are analyzed in detail. This procedure provides corrected neutron spectra in the region from about 1 keV up to several MeV. The computer programs used in this treatment (WERM, ITERATE, and PSNS) are discussed, and a sample problem illustrates and explains the manner in which these codes function. (auth)

49068 (BNL-12798) STATE OF THE ART OF LOW NOISE AMPLIFIERS FOR SEMICONDUCTOR RADIATION DETECTORS. Radeka, Veljko (Brookhaven National Lab., Upton, N. Y.). [1968]. 28p. (CONF-680906-4). Dep. CFSTI.

From International Symposium on Nuclear Electronics, Versailles, France.

The state of the art of charge amplifiers with respect to noise, rise time, gain linearity, and response is determined by the field-effect transistors, by the high-frequency bipolar transistors, by the feedback (bias) resistor, and by the dielectrics in the input circuit. A condensed discussion of the relations between amplifier properties and parameters of these devices is presented. Special attention is given to identification of various noise sources. Some data on field-effect transistors, resistors and dielectrics are given. Simultaneous achievement of low noise, high speed, linearity, dynamic range and a well defined time response is considered. A rise time of 15 nanoseconds was obtained with a detector capacitance of 50 pF. A short rise time of this order of magnitude is of interest for timing and for studies of charge collection processes in semiconductor detectors. A method is given for measurement of gain nonlinearity under simulated conditions of high pulse rate. It is shown that the gain nonlinearity is related to the rise time. (auth)

49069 (JEN-194-IFIC/I-58) STUDY OF SOME TECHNICAL PROBLEMS IN NUCLEAR EMULSIONS. Tarrega Tornero, M. Pilar (Junta de Energia Nuclear, Madrid (Spain). Division de Fisica). 1967. 21p. (In Spanish). Dep.

A methodological study of various technical aspects of photographic emulsions is presented. Variation of different ionization indices with the degree of development is studied. A measure of the degree of development, called the α-mark, is based on the average width of tracks due to α-particles. Using the α-mark the influence of several factors such as the duration, temperature and concentration of the developing liquid are investigated. A comparative study of the sensitivity of Ilford C2 and K2 emulsions is given. Also, the α-mark is used to study the influence of temperature and humidity on the speed of fading. Discrimination of high-energy particles by ionization measurements is discussed. By measuring the momentum and the relative ionization of very energetic particles, the effect of the developing liquid with depth in emulsion is studied. Also, a stack of Ilford K5 emulsion of pellicles thickness 600μ m was exposed to a beam of 800-MeV pions produced in the CERN proton synchrocyclotron. In an attempt to reduce distortion, part of the stack was treated with colofon-resin. The results of different methods of development on the distortion of resin-treated emulsion are given. (auth)

49070 (JPRS-46486) PROBLEMS IN RADIOISOTOPE SCINTIGRAPHY. Translation of papers SM-108/36 and SM-108/37 from IAEA Symposium on Medical Radioisotope Scintigraphy, Salzburg, Austria, 6-15 August 1968. 28p. CFSTI.

The Kolmogorov-Wiener technique is used for estimating spatial distributions of radioactive isotopes. Sliding mean meters and count rate meters are compared as average rate meters for radioisotope scanning. (J.W.R.)

49071 (NRC-TT-1337) MEASUREMENT OF DEAD TIMES BY THE METHOD OF COINCIDENCES. Granados, C. E.; Vigon, M. A.; Verdaguer, F. Translated by D. A. Sinclair for National Research Council of Canada, Ottawa, from An. Real Soc. Espan. Fiz. Quim. (Madrid), Ser. A, 63: 155-9(1967). 8p. Dep.

The correction formula for a very particular case of coincidence counting with different non-extending dead times in the two detector channels is derived. This formula provides a simple and accurate general method for measuring non-extending dead times. (auth)

49072 (ORNL-TM-2273) GAMMA-RAY RESPONSE OF THE NE-213 LIQUID SCINTILLATION DETECTOR. Fu, C. Y.; Cain, V. R.; Straker, E. A.; Stevens, P. N.; Muckenthaler, F. J. (Oak Ridge National Lab., Tenn.). Aug. 1, 1968. Contract W-7405-eng-26. 47p. Dep. CFSTI.

The response of an NE-213 scintillation counter to gamma rays has been calculated with the OGRE-G Monte Carlo gamma-ray transport code modified to include the transport of Compton electrons. Since the calculation model did not explicitly include statistical fluctuations due to variations in the intensity of light produced by the scintillator, nonuniformities in the transmission of the light pulse to the photomultiplier, nonlinearities in the conversion of the light pulse into an electrical pulse by the photomultiplier, and variation in the amplification of the pulse, the application of two correction factors to the Monte Carlo results was required. The resulting calculated responses were in excellent agreement with experimental data. Comparisons of the calculated responses with experimental data are presented for gamma-ray source energies from 0.66 to 6.13 MeV. (auth)

49073 RADIATION DETECTOR WHOSE OUTPUT IS INDEPENDENT OF THE ENERGY DISTRIBUTION OF INCIDENT RADIATION. Hosemann, Rolf; Warrikhoff, Harald. U. S. Patent 3,398,282. Aug. 20, 1968. Filed Dec. 1, 1964.

A detector electrode structure composed of two electrodes at least one of which consists of a plurality of layers each made of a material and having a thickness such that the radiation responsive charge carrier emission characteristics of the layers combine to cause the net flow of charge carriers between the electrodes to be independent of the energy distribution of the incident radiation is described. (auth)

49074 DETECTOR FOR LOCAL MEASUREMENT OF FAST NEUTRON FLUX. Balducci, Gilberto; Martini, Massimo; Pedrini, Alfredo (CNEN, Rome). pp 575-88 of Fisica del Reattore. Rome, Consiglio Nazionale delle Ricerche, 1966. (In Italian).

From Conference on Physics of Reactors, Milan. See CONF-469.

Preparation of the solid state detector for the fast neutron fission chamber is discussed. Deposition of the fissile material in thin films is described; film dimensions are given. The evacuated area of the fission chamber, in which the neutron detector is placed, is described; operation of the chamber is outlined. Alpha emission spectra are shown for thorium, natural uranium, depleted uranium, and uranium enriched in ^{235}U. A block diagram is given of the equipment for gamma and beta counting. Plateau regions for the proportional counter and fission chamber are shown graphically. The working model for calculating spectral indices is given. Use of the detecting system is discussed briefly. (11 references.) (M.L.S.)

49075 ALPHA TRACK AUTORADIOGRAPHY OF SUB-MICRON AEROSOL PARTICLES WITH THE ELECTRON MICROSCOPE. Heard, M. J.; Wiffen, R. D. (Atomic Energy Research Establishment, Harwell, Eng.). Nature (London), 219: 1245-8 (Sept. 21, 1968).

Monolayers of nuclear emulsion grains have been used for low energy β autoradiography in biological work. Beta-emitters of different energies can be separately identified by applying compound layers of emulsion and absorber. This, however, represents essentially single grain autoradiography. Track autoradiography can give a clearer picture of the location of radioactive materials, and this is particularly true of α-particles, the linear tracks of

which can be extrapolated. Some studies in this field are described. For efficient alpha track autoradiography of sub-micron particles using the electron microscope it is necessary to reduce the overall thickness of the processed photographic emulsion without drastically reducing its sensitivity or unprocessed thickness. A method of doing this by reducing the gelatin content of the emulsion is described. Part of the gelatin is removed before the emulsion is coated on the specimen, by treatment with warm water and centrifugation. The residual gelatin is strongly absorbed and it is not possible to remove any significant part of it by non-chemical methods. In work with particulates, 0.05 to 0.1 μ of gelatine can be tolerated, especially if microscopy is conducted at 100 kV. Techniques and applications are described, and some examples are illustrated. (UK)

49076 FOCUSSING THE XP1020 PHOTOMULTIPLIER FOR MINIMUM TIME SPREAD. Stanchi, L. (EURATOM, Ispra, Italy). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-15: No. 5, 21-2(Oct. 1968).

The layout for the XP 1020 photomultiplier is shown and adjustment for focusing for minimum time spread are described. (J.W.R.)

49077 NOTE ON THE S^2/B CRITERION OF QUALITY FOR COUNTING EQUIPMENT. Porges, K. G. (Argonne National Lab., Ill.). Int. J. Appl. Radiat. Isotop., 19: 711-12(Sept. 1968).

The maximum signal^2/background ratio criterion, widely held to be crucial in the choice, design, and adjustment of counting equipment, applies only in experiments where the aim is the detection of a very small signal rate, not necessarily with the highest precision. Maximum signal strength is more important for the measurement of signal rates, possibly well above background, with very high precision and in the shortest possible time. (UK)

49078 CALCULATION OF THE SIGNAL-TO-NOISE RATIO FOR AN EXPERIMENT ON THE CORRELATION OF PHOTONS EMITTED FROM CASCADE. II. MONTE CARLO METHOD. Camhy-Val, C.; Dumont, A. M. (CNRS, Paris). Nucl. Instrum. Methods, 64: 211-13(Sept. 15, 1968). (In French).

A Monte Carlo method is used to calculate the signal-to-noise ratio for an experiment involving correlated photons from an atomic cascade. The source depth is taken into account. (auth)

49079 PRELIMINARY RESULTS ON THE HOLES PREFERENTIAL TRAPPING IN HIGH RESISTIVITY Si SURFACE BARRIER DETECTORS. Nasini, M. (CISE, Milan); Ottaviani, G.; Redaelli, G. Nucl. Instrum. Methods, 64: 235-6(Sept. 15, 1968).

Some experimental results on the holes preferential trapping in the high resistivity Si surface barrier detector are given. The measurements are performed at two different temperatures. (auth)

49080 PRECISE FORM OF THE EFFICIENCY EQUATION FOR A Ge(Li) DETECTOR. Tokcan, G.; Cothern, C. R. (Univ. of Dayton, Ohio). Nucl. Instrum. Methods, 64: 219-20(Sept. 15, 1968).

The applicability of the semi-empirical relation used by Freeman and Jenkin to lower energies (down to 200 keV) is examined. (auth)

49081 ON THE VARIATION WITH TIME OF THE DRIFT REGION IN Si(Li) DETECTORS. Antonov, A. (Univ., Sofia); Yuskesselieva, L. Nucl. Instrum. Methods, 64: 217-18(Sept. 15, 1968).

The boundary variation of the drift region in Si(Li) detectors is investigated experimentally and theoretically. (auth)

49082 ON THE ORIGIN OF LEAKAGE CURRENT IN Ge(Li) GAMMA-RAY DETECTORS. McIntyre, R. J. (RCA Victor Co., Ltd., Montreal). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-15: No. 5, 6-8(Oct. 1968).

Hole-electron pair generation in Ge(Li) γ-ray detectors due to thermal radiation from the cryostat outer casing is suggested as an often overlooked source of detector leakage current. Thermal-radiation-induced currents of the order of 10^{-9} A are estimated for a typical large coaxial detector at 77°K when the cryostat outer casing is at 300°K. (auth)

49083 ISOTOPE SCANNER WHICH CREATES X-RAY AND GAMMA RADIATION IMAGES SIMULTANEOUSLY. Anger, Hal O. (to United States Atomic Energy Commission). U. S. Patent 3,405,233. Oct. 8, 1968.

A radiation detecting device is described for creating an image showing the distribution of a gamma emitting radioactive substance in a patient, together with an x-ray image formed concurrently, to aid in accurately determining the location of the radioactive substance. A row of radiation sensing devices are scanned along the patient, detecting both x-rays and gamma-rays, with pulse-height analyzers to separate the x-ray and gamma-ray signals received from the detectors so that both an x-ray image and a gamma-ray image are formed. (AEC)

49084 AN INVESTIGATION OF THE LIMITATIONS OF A PULSE-TYPE NEUTRON DETECTOR FOR THE ANALYSIS OF REACTOR NOISE. Trinko, Joseph Richard Jr. Knoxville, Tenn., Univ. of Tennessee, 1967. 173p.

Thesis.

The problem undertaken was to determine the limitations imposed by counting loss, gamma flux, and scaling upon a pulse type neutron detection system designed for the analysis of reactor noise. The purpose of the study was to explore the merits of a detection system capable of gamma rejection. Such a system could extend the applicability of noise analysis to reactors having large gamma fluxes and low neutron fluxes. The neutron detector consisted of a cluster of B_{10} lined proportional counters having a short electron collection time (60 nanosec.). Detector pulses were amplified and applied to a discriminator. Since neutron-induced pulses were much larger than gamma-induced pulses, the smaller gamma-induced pulses could, in principle, be eliminated from the signal by pulse height discrimination. The discriminator output was applied to a counting rate meter having a short time constant (15 μsec.), thereby generating a voltage signal proportional to the instantaneous neutron counting rate. Power spectral density (PSD) measurements were taken upon the fluctuating voltage signal when the detector was exposed to various radiation flux conditions. To establish the effect of counting loss, PSD measurements were taken under conditions of counting loss ranging from 1% to 20%. It was found that the detection efficiency decreases nonlinearily with increasing counting loss. Estimates of neutron generation time obtained from PSD data were found to be quite insensitive to counting loss up to 20% counting loss. The effect of gamma rays was determined by performing PSD measurements upon the system when the detector was exposed to various known gamma fluxes. The results indicate that gamma rays have practically no effect on PSD when the gamma flux is less than 10^4 roentgen/hr. Above this value, the pile-up of gamma-induced pulses together with space-charge effects cause a rapid deterioration in the quality of the measurement. However, there exists a region of flux conditions within which the pulse system performs better than the best ion chamber available. This region has upper bounds of 1.1×10^5 roentgen/hr and 4×10^4 nv. The region is controlled by the neutron and gamma sensitivities of the pulse system. These measurements indicate that the neutron sensitivity decreases quite rapidly in gamma fluxes above 10^5 roentgen/hr because of space-charge. To establish the effect of scaling, PSD measurements were taken with scale factors of 2, 4, 8, and 64. It was established that that portion of the PSD spectrum containing reactor information ($1-10^3$ Hz.) is not affected by scaling if the average counting rate after scaling is sufficiently high (greater than 10^4 counts/sec.). (Disser. Abstr.)

49085 HIGH VOLTAGE OPERATION OF GROOVED Si(Li) DETECTORS. Ristinen, R. A. (Univ. of Colorado, Boulder). Nucl. Instrum. Methods, 64: 201-4(Sept. 15, 1968).

Some characteristics of the high voltage operation of geometrically contoured Si(Li) detectors are described. Improved charge collection is obtained as detector bias voltage is increased up to at least 600 V/mm of drifted depth. (auth)

49086 SUBTRACTION METHOD FOR HIGH INTENSITY COUNTER EXPERIMENTS. Kuroda, K.; Dufournaud, J. (Institut de Physique Nucleaire, Orsay, France). Nucl. Instrum. Methods, 64: 109-20(Sept. 15, 1968).

A method based on a linear substraction of photomultiplier pulses is proposed for the purpose of decreasing accidental counting rates in some counter experiments, and is tested in order to realize a beam hodoscope working at a very high beam intensity. The results confirm a good performance of the substraction system. A Monte Carlo calculation of the efficiency shows that, compared with an ordinary hodoscope, a considerable gain can be expected at a high beam-intensity region of 10^9 particles/sec. (auth)

49087 MEASUREMENT OF THE RESPONSE OF SEVERAL ORGANIC SCINTILLATORS TO ELECTRONS, PROTONS, AND DEUTERONS. Smith, D. L.; Polk, R. G.; Miller, T. G. (Army Missile Command, Redstone Arsenal, Ala.). Nucl. Instrum. Methods, 64: 157-66(Sept. 15, 1968).

The response of several common organic scintillators to electrons, protons and deuterons has been measured using a photomultiplier tube with S-11 spectral sensitivity. The Compton

scattering of monoenergetic beams of gamma rays and neutrons were used to induce the charged particles to recoil with specific energies in the interiors of the scintillators. Pulse-shape discrimination was employed to distinguish between neutron and gamma-ray events. The following scintillators were studied as indicated: anthracene (electrons: 0.23–0.99 MeV, protons: 0.24–15.0 MeV); stilbene (electrons: 0.31–0.99 MeV, protons: 0.35–15.0 MeV); NE-213 (electrons: 0.16–0.99 MeV, protons: 0.24–15.0 MeV); NE-102 (electrons: 0.31–0.99 MeV, protons: 0.35–15.0 MeV); Pilot B (electrons: 0.31–0.99 MeV, protons: 0.35–15.0 MeV); and NE-230 (electrons: 0.16–0.99 MeV, deuterons: 0.25–11.0 MeV). All measured responses for a given scintillator were normalized to its measured response for 0.525 MeV electrons (arbitrarily assigned the value 1000). These data were used to compute p/β and d/β ratios which are relatively insensitive to detector geometry. The scintillators studied exhibit ratios which are remarkably similar over a wide range of particle energies. They increase non-linearly from ≈0.1 in the 0.3–1.0 MeV range to ≈0.5 in the 12.0–15.0 MeV range. (auth)

49088 CONSIDERATIONS ON THE DISTURBING EFFECT OF PHOSPHORESCENCE AND THAT OF AFTER-PULSING IN MEASURING THE ABSOLUTE ACTIVITY OF LOW ENERGY BETA ISOTOPES. Fodor-Csanyi, P.; Szilagyi-Gyoeri, E. (Eoetvoes Lorand Univ., Budapest). Int. J. Appl. Radiat. Isotop., 19: 712-13(Sept. 1968).

Determination of the absolute activity of low energy beta-emitting isotopes involves many difficulties. In this connection Steyn's extrapolation method (Proc. Phys. Soc. A, 69: 865 (1956)) is important. The basic principle of this method is described. The integral spectrum of the beta isotope is measured with a single-channel liquid scintillation counter, giving a straight line over a certain discriminator voltage. The linear part of the curve is then extrapolated to zero discriminator voltage. This value gives the absolute activity above a certain energy level determined by the measuring parameters. The non-linear part of the curve has been attributed to constructional characteristics of the photomultiplier tube, leading to after-pulsing and increasing the counting level. After-pulsing has been considered to be due to that part of the noise of the photomultiplier tube which is not changing with temperature, being caused by the presence of positive ions. In the experimental work described the extrapolation method was used for measuring the absolute activity of ^{36}Cl, ^{14}C and ^{3}H in solutions containing water. The integral spectrum of all three isotopes was linear. If, however, the samples were not in dark for due time before measuring, the integral spectrum showed a non-linear component, due to phosphorescence. The signal level due to phosphorescence is of the same order as that of the signals generated by soft β-emitters. With elimination of phosphorescence the whole curve becomes linear. (UK)

49089 RADIATION ALARM SYSTEM FOR SCATTERED X RAYS. Moore, M. J.; Sorensen, N. B. (G.E.C., Schenectady, N. Y.). Health Phys., 15: 362-3(Oct. 1968).

The system described is designed to give both a visible and audible alarm if the radiation level rises above a preset limit. It can be attached to any type of survey instrument, but it is necessary, when monitoring scattered x-rays, to use a survey instrument which is sensitive to radiation below 15 keV. The system, exclusive of the survey meter can be constructed for less than $150.00. (auth)

49090 BACKSCATTERING AND BREMSSTRAHLUNG ELECTRONS IN A SILICON DETECTOR. Waldschmidt, M.; Wittig, S. (Univ., Frankfurt am Main). Nucl. Instrum. Methods, 64: 189-91(Sept. 15, 1968).

Pulse height distributions of a silicon semiconductor counter were measured for monoenergetic electrons in the energy range from 300 to 1200 keV at angles of incidence from 15° to 90°. The fraction of electrons not totally absorbed in the sensitive volume is determined. The spectra were also calculated with a Monte Carlo method, taking into account backscattering and bremsstrahlung. The fraction of the low energy tail of the detector response to perpendicularly incident electrons is found to be nearly independent of energy, for both measurements and calculations. The value determined is about 0.2. (auth)

49091 LOW-NOISE CHARGE PREAMPLIFIER FOR LITHIUM-COMPENSATED GERMANIUM DETECTORS OF LARGE SENSITIVE VOLUME. Siffert, P.; Regal, R. (Centre de Recherches Nucleaires, Strasbourg). Rev. Phys. Appl., Suppl. J. Phys., 3: 107-10(June 1968). (In French).

A charge preamplifier, associated with a germanium-lithium γ-ray detector of large sensitive volume (85 cm^3), is described. This preamplifier uses, as input element, a field effect tetrode transistor. When the transistor is cooled to 150°K and used with the gamma counter, a 4.3 keV FWHM for a 1.33 MeV γ-ray may be attained. (auth)

49092 THEORETICAL AND PRACTICAL LIMITS OF RESOLUTION OF SEMICONDUCTOR DETECTORS. Karolyi, Gyula (Nuclear Research Inst., Debrecen, Hungary). Magy. Fiz. Foly., 16: 263-77(1968). (In Hungarian).

Resolution of a detector may be defined on the basis of the standard deviation of the pulse amplitude. Fluctuation of the signal may be due on one hand, to the statistical velocity distribution of the charge carriers in the semiconductor, surface effects, and electronic noise, and on the other hand, to the interaction between the detector and the particle. The components of the noise, such as thermal noise, current-induced noise, generation-recombination noise, are analyzed. In studying the interaction-induced statistical fluctuations, it is assumed that the total energy of the incident particles is completely absorbed in the sensitive areas of the detector. In order to minimize the noise in spectrometers based on semiconductor detectors, it is desirable to use a low-capacitance, low-reverse-current and low-volume detectors with an optimized amplification system. The mechanism of interaction requires further experimental study. (TTT)

49093 RADIATION MEASUREMENTS IN SPACE. Gorn, L. S.; Khazanov, B. I. Usp. Fiz. Nauk, 95: 353-81(June 1968). (In Russian).

The basic trends in the construction of research apparatus for radiation measurement in space are examined. The characteristics of radiation in interplanetary space, caused by primary cosmic radiation, solar winds, chromospheric flares of the sun, aurora, radiation, magnetic traps of the earth, are given. The most characteristic methods and devices for the detection of protons of medium and high energy, electrons of medium and high energy, charged particles of low energy, and neutron, and x and γ radiation are examined. A comparison is made of the various detection methods; parameters of the devices presently used on various sputniks and space rockets are given. The performance of recorders and analyzing installations and instruments for the radiation measurement in space is examined. (tr-auth)

Nuclear Spectroscopic Instrumentation

Refer also to abstracts 50496 and 50626.

49094 (AERE-R-5653) ITERATIVE UNFOLDING OF COMPTON SPECTRA. Silk, M. G. (Atomic Energy Research Establishment, Harwell (England)). June 1968. 21p. Dep. CFSTI. UK 3s. 6d.

The iterative method of solving the Fredholm equation was considered as a means of unfolding Compton spectra, and numerical experiments, using both experimental and imaginary spectra, were carried out to determine the suitability of the technique for this problem. Particular regard was paid to the possibility of unfolding the Compton spectrum produced by the γ-ray flux in a nuclear reactor. (auth)

49095 (IS–1950) CONSTRUCTION AND ALIGNMENT OF A HIGH-RESOLUTION BETA-RAY SPECTROMETER. Eitter, Joseph J.; Talbert, W. L. (Ames Lab., Iowa). Aug. 1968. Contract W-7405-eng-82. 59p. Dep. CFSTI.

A high resolution beta-ray spectrometer is described which was constructed for the study of short-lived activities provided by an online isotope separator at the Ames Laboratory Research Reactor. Details of the construction of components of the spectrometer are presented, along with auxiliary equipment including the spectrometer field control and stabilizing systems. The procedure is described for alignment of the spectrometer in a high-aperture mode of operation. The performance of the aligned spectrometer is compared to a similar instrument at the University of Colorado. For the K-conversion line of the 329-keV transition in the decay of ^{198}Au, the spectrometer has a measured resolution of 0.12% for a luminosity of 1.66×10^{-3} cm^2 (0.28% of 4π transmission) and 0.17% for a luminosity of 7.08×10^{-3} cm^2 (1.21% of 4π transmission). (auth)

49096 (ORNL-TM-2172) SEGO: A COMPUTER CODE FOR UNFOLDING EXPERIMENTAL PULSE-HEIGHT DISTRIBUTIONS. Burrus, W. R.; Young, M. H. (Oak Ridge National Lab., Tenn.). July 3, 1968. Contract W-7405-eng-26. 61p. Dep. CFSTI.

A mathematical procedure is described for unfolding scintillation pulse-height spectra to obtain an estimate of the incident energy spectra. Two methods have been developed, both giving equivalent numerical answers. The first method, known as Low Speed Sego, reduces the number of arithmetic operations for an N channel spectrum from the order of N^3 for conventional matrix

inversion methods to the order of N^2 and simplifies the problem of constructing a model for the response of the spectrometer. The second method, known as High Speed Sego, further reduces the number of arithmetic operations to the order of 10N instead of N^2. High Speed Sego makes use of the same ideas as Low Speed Sego and, in addition, transforms the response matrix of the spectrometer in such a way as to produce a large number of zero elements. This transformation is only applicable if the Hyodo response function can be represented by straight-line segments plus peaks (or by parabolic segments in a version under development known as Double High Speed Sego). (auth)

49097 (ORNL-TM-2246) TRIPLE-AXIS NEUTRON SPECTROMETER–COMPUTER INTERFACE. Madden, E.; Reynolds, J. W.; King, S. P. (Oak Ridge National Lab., Tenn.). July 24, 1968. Contract W-7405-eng-26. 65p. Dep. CFSTI.

An interface was constructed so that a PDP-8 computer can be used to control the experimental apparatus and data acquisition devices for a triple-axis neutron spectrometer. Up to eight Slo-Syn stepping motors can be positioned. The count rates of the primary neutron beam (before it passes through the monochromator), the incident neutron beam (after it passes through the monochromator), and the diffracted neutron beam are measured, and the adjusted intensity measurements of the diffracted beam are recorded as a histogram plot. The design and construction of the interface system, the input and output circuits, interface operation requirements, motor test and photomarker set-up procedures, and other details are summarized.

49098 USE OF THE LIQUID SCINTILLATOR NE 214 IN A NEUTRON TIME-OF-FLIGHT SPECTROMETER WITH A SIMPLE NEUTRON–GAMMA DISCRIMINATION. Mueller, W. D.; Aldefeld, B.; Langkau, R. (Institut fuer Experimentalphysik, Hamburg). Nukleonik, 11: 208-10(July 1968). (In German).

The light yield efficiency of the liquid scintilltor NE 214 for protons and the neutron-gamma discrimination characteristics were investigated. The scintillator was used in a fast-neutron time-of-flight spectrometer. The particle separation was accomplished using the space-charge method. The space-charge pulse is used simultaneously for the conduction of time signals. (tr-auth)

49099 GAMMA SPECTROMETRIC DETERMINATION OF THE ACTIVITY RATIO BETWEEN ^{228}Th AND ITS DECAY PRODUCTS. II. CALCULATION OF THE ACTIVITY RATIO BY ENERGY SPECTRA. Heyder, J.; Kaul, A. (Max-Planck-Institut fuer Biophysik, Frankfurt am Main). Biophysik, 5: 99-110(1968). (In German).

A mathematical method is described which allows the determination of the Ra-224 and Pb-212 activities of tissue samples containing thorotrast at the time of extirpation from results of gamma ray spectrometry by transformation of the measured pulse height spectra into energy spectra. The activities are calculated from the variation with time of the quantum rate within the 0.24 MeV energy interval. Results of calculations of the activity ratios between Th-228 and Ra-224 or Pb-212 by the method described are compared to those estimated by the variation with time of the Tl-208 activities of spleen samples from rabbits with a thorotrast body burden of 2 ml. Moreover the errors of the results of both methods are put together and compared. (auth)

49100 EXPERIMENTAL INVESTIGATIONS BY CRYSTAL DIFFRACTION. Nilsson, Sam. Doktorsavhandlingar vid Chalmers Tekniska Hogskola. Goteborg, Chalmers Tekniska Hogskola, Goteborg, 1968. 10p.

A summary is made of 15 published papers by the author on the following subjects: loading device for irradiated samples at a bent crystal spectrometer; decay of the ground state of ^{165}Dy; reactor irradiation containers, titanium and electrolytic iron; precision energy determination of isomeric levels and of low-lying levels in deformed nuclei; a double flat crystal spectrometer for (n, γ) studies; a crystal diffraction spectrometer for non-destructive burnup analysis; some investigations of flat germanium single crystals; intensity measurements with a bent crystal spectrometer; investigations of aluminium single crystals by use of gamma rays; non-destructive analysis of irradiated fuel samples by crystal diffraction; a data recording system with punched tape for a crystal diffraction spectrometer; determination of the K-conversion coefficient of the $2^+ \rightarrow 0^+$ transition in ^{170}Yb and ^{166}Er; a flat crystal spectrometer for (n,γ) studies; the IAEA safeguards system; and experimental investigations by crystal diffraction. (Swed)

49101 CARRYING OUT CROSS SECTION MEASUREMENTS BY MEANS OF A MECHANICAL NEUTRON PULSER. Casali, F.; Coceva, C.; Corvi, F.; Giacobbe, P.; Stefanon, M. (CNEN, Ispra, Italy). pp 839-45 of Fisica del Reattore. Rome, Consiglio Nazionale delle Ricerche, 1966. (In Italian).

From Conference on Physics of Reactors, Milan. See CONF-469.

The neutron time-of-flight spectrometer at CNEN's Ispra Research Center is described. Spectrometer components are described; these include neutron source, collimator, chopper, detector, and analyser. (M.L.S.)

49102 MEASUREMENT OF NEUTRON SPECTRUM AND TEMPERATURE USING A CRYSTAL SPECTROMETER. Domenici, Marcello; Zucca, Tarcisio (SORIN, Saluggia, Italy). pp 519-31 of Fisica del Reattore. Rome, Consiglio Nazionale delle Ricerche, 1966. (In Italian).

From Conference on Physics of Reactors, Milan. See CONF-469.

The thermal neutron spectrum was measured using a spectrometer normally used for neutron diffraction and a copper single crystal in reflection. The counting rate is presented as a function of the Bragg angle between 6 and 40 degrees, which corresponds to an energy range of 0.011 to 0.43 eV. The results are corrected to obtain the effective spectrum as a function of energy and to deduce the neutron temperature. The higher order contamination has been corrected only for the second order, considering the experimental curve as the sum of two Maxwellian distributions. (auth)

49103 ANALYZER FOR NUCLEAR SPECTROMETRY. (to Laben Laboratori Elettronici e Nucleari SRL). British Patent 1,128,468. Sept. 25, 1968. Priority date Oct. 22, 1964, Italy.

An analyzer system for nuclear spectroscopy is described. The system comprises a multichannel analyzer, analog-to-digital converter, memory device, and readout system. (W.H.K.)

49104 SOME EXPERIENCES IN THE USE OF SEMICONDUCTOR DETECTORS FOR FISSION STUDIES IN THE HIGH-ENERGY PROTON BEAM AT CERN. Brandt, Reinhard (CERN, Geneva); Krogulski, Tadeusz; Piasecki, Eryk; Piekarz, Henryk; Sowinski, Mieczyslaw; Chwaszczewska, Janina; Moszynski, Marek. Nukleonika, 13: 845-57(1968).

Two test experiments are described in which the semiconductor technique has been applied to fission studies in a high-energy proton bean at the CERN Proton Synchrotron (PS). The technical details of an experimental procedure are described. Some preliminary results on fission in uranium induced by 14 GeV protons are given. (auth)

49105 INSTRUMENTAL EFFECTS THAT MAY INFLUENCE BETA SPECTRAL SHAPE MEASUREMENTS IN MAGNETIC SPECTROMETERS. Howe, D. A. (Texas Technological Coll., Lubbock). Nucl. Instrum. Methods, 64: 231-2(Sept. 15, 1968).

Very slight energy dependence of the resolution of transmission of magnetic spectrometers can produce or mask the shapefactor $(1 + 0.3/W)$ reported by Langer et al. The effect of an energy dependent resolution of the form $R = R_0(1 + \alpha W)$ is examined. It is concluded that tests usually conducted on most magnetic spectrometers are not sensitive enough to detect $|\alpha| = 0.02$, which is large enough to interfere with spectral shape measurements. (auth)

49106 STUDY OF SCINTILLATION SPECTROMETRY: ERROR ANALYSIS. Su, Yung Sung; Shih, Shy Min (National Tsing Hua Univ., Taiwan). Energ. Nucl., 15: 666-75(Oct, 1968).

The errors arising in scintillation spectrometry through the use of the matrix method to approximate the integral equation are analyzed. It is found that the statistical error is not large and can be reduced to a negligible amount if a suitable arrangement of experiments is made. A mathematical model is proposed which simulates an ideal measurement of the multichannel analyzer, and reveals the effects of approximation of matrix representation of the response function, and of the methods used to reconstruct the spectra. Two methods of approximation, the right point method and the Simpson rule method, together with three methods of reconstruction: matrix method, least square method, and Schofield's iteration method, are used. It is concluded that the matrix approximation to an integral equation is at fault and is the main source of uncertainty. It is also found that Scofield's iteration and least square methods, coupled with right point approximation, are far superior to the matrix method. (auth)

49107 HIGH-RESOLUTION ENERGY-LOSS ANALYZER FOR INELASTIC ELECTRON SCATTERING. Muir, Douglas William. University Park, N. Mex., New Mexico State Univ., 1968. 182p.

Thesis.

A novel electron energy-loss analyzer is proposed for the study of discrete nuclear excited states by means of inelastic electron scattering at electron energies below 30 MeV. At these low energies, the detailed effects of finite nuclear size are reduced, so that one can extract the radiative width (life-time) of the excited state

without having to assume a particular model of the nucleus. In spite of this desirable feature, very few inelastic electron scattering experiments have been performed below 30 MeV, primarily because of a fundamental background problem. This background is associated with electrons that lose energy in the target because of bremsstrahlung generation rather than nuclear excitation, and it increases rapidly as the incident electron energy E is lowered. An optimum scattering angle θ for low energy experiments is 180°, where the transverse interaction between the electron and nucleus can be studied with a minimum of interference from the bremsstrahlung background. The nuclear levels which are excited most easily at these large scattering angles are those which are connected to the ground state by magnetic dipole (M1) transitions. Calculations indicate that most ground-state M1 transitions which are allowed by rotational and isospin selection rules should be seen above the bremsstrahlung background throughout the region of light nuclei (Z less than 20), provided that one can devise a system which measures the energy loss w of the scattered electrons with a resolution Δw of about 10^{-3} E. Several possible energy-loss analyzers are discussed, and the attainable resolution of each is estimated. In particular, one system would allow measurements with Δw around 5×10^{-4} E, even if the uncertainty in the initial electron energy is as large as 8×10^{-2} E. The basic approach here involves spreading the different energy components of the beam over the target in a manner which compensates for the inherent dispersion in the post-scattering energy analyzer. This approach has been used in other electron experiments, but it apparently has never been applied to large-angle inelastic scattering. For this reason, special attention is given to practical problems which might interfere with the operation of such a device. The only serious difficulty indicated by calculations, for the assumed target-magnet-detector geometry, is the background counting rate due to elastically scattered electrons from the target which are rescattered from the pole faces of the analyzer magnet into the detector. A more sophisticated detector scheme is suggested which would probably reduce this counting rate to a tolerable level. Some of the particular experiments which one could hope to perform with such a high-resolution energy-loss analyzer are also discussed. (Disser. Abstr.)

49108 GAMMA-RAY PULSE-HEIGHT SPECTRA: FORMATION OF A RESPONSE MATRIX FOR ITERATIVE UNFOLDING. Sam, D.; Bunney, L. R.; Heater, D. C. (Naval Radiological Defense Lab., San Francisco). Nucl. Instrum. Methods, 64: 148-56 (Sept. 15, 1968).

One method for obtaining gamma-ray spectra is the application of the iterative unfolding technique to the measured pulse-height spectra. This technique, however, requires the construction of a response matrix which contains a series of response functions of the detector assembly to various gamma-ray energies. The essential steps in the construction of a response matrix, having the dimensions 100 energy bins and 1024 channels, used to obtain the complex gamma-ray spectra from the experimental pulse-height spectra are described. The photons of interest have an energy range extending from 0.060 to 5.00 MeV. The report also describes the associated computer programs for generating and using the response matrix. The results of unfolding of synthesized pulse-height spectra having a known number of gamma rays of known energy are presented. The computer programs are written in Fortran II language for use with an IBM-704 computer. (auth)

49109 RISETIME SPECTROMETER FOR STUDYING PULSE SHAPES IN Ge(Li) GAMMA-RAY DETECTORS. Sakai, Eiji.; McMath, T. A. (Atomic Energy of Canada Ltd., Chalk River, Ont.). Nucl. Instrum. Methods, 64: 132-40(Sept. 15, 1968).

A risetime spectrometer has been developed to study the shape and distribution of shapes of γ-ray pulses from Ge(Li) detectors. This instrument employs a time-to-amplitude converter, a multichannel pulse height analyzer, and two discriminators to measure the distribution of times required for full-energy pulses to reach a predetermined fraction of full pulse height. Using the risetime spectrometer and collimated beam techniques, pulse shapes from a planar and a coaxial detector were determined as a function of the position of irradiation in the detector. The measured pulse shapes were in close agreement with calculated pulse shapes. (auth)

49110 A FAST STORAGE SYSTEM FOR PULSE-HEIGHT DATA AND EXPERIMENTS ON 31-MILLISECOND ^{155m}Gd. Etzion, Moshe. Ithaca, N. Y., Cornell Univ., 1968. 182p.

Thesis.

A fast temporary storage system for pulse amplitudes was developed for use in pulse-height analysis of millisecond half-life isomers. The system can store about a thousand pulses and has a uniform dead-time of 5 μsec. The pulse-height resolution is comparable to that of a 128 channel digital pulse height analyzer. The storage device is an electrostatic storage tube using magnetic focussing of deflection for optimum resolution. Pulses are stored as dots of charge along vertical lines, their amplitude being represented by the distance of the dot from a preset baseline. The lines are equally spaced in predetermined horizontal positions. Several dots (typically, five) can be stored on any one line. Experiments on 31-millisecond ^{155m}Gd are described. The isomer was produced by pulsed neutron irradiation of a sample enriched in ^{154}Gd in the Cornell TRIGA reactor. A fast pneumatic transfer system transported the irradiated sample to a detection station in 50 msec. Gamma and X-ray measurements were performed using Ge(Li) and NaI(Tl) detectors. Energies of 86.2 ± 0.4 keV and 42.7 ± 0.45 keV were measured corresponding to the known second excited state of ^{155}Gd ($T_{\frac{1}{2}}$ = 5 nsec) and to gadolinium K X-rays. The isomeric transition was not observed. However, the absence of both K and L X-rays corresponding to this transition places the isomeric state within several keV above the 86.5 keV level. The isomeric half-life is consistent with an enhanced E3 transition. An $11/2^-$ E3 $5/2^+$ transition to the 86.5-keV level is therefore possible, supporting the hypothesis that the isomer is due to the $11/2^-$ [505] Nilsson state. However, since so far even the spin of the 86.5-keV level has not been uniquely determined, further work is necessary before this hypothesis can be verified. The isomer half-life was determined as 31.4 ± 1.5 msec. The K conversion coefficient of the 86.5-keV level was calculated from spectra of both detectors. The results were 0.39 ± 0.03 for the Ge(Li) spectra and 0.43 ± 0.03 for the NaI(Tl) spectra. Both results agree with the known value of this conversion coefficient. (Diss. Abstr.)

49111 IMPROVEMENTS RELATING TO NUCLEAR SPECTROMETRY. (to Laben Laboratori Elettronici E Nucleari SRL). British Patent 1,127,905. Sept. 18, 1968. Priority date Oct. 22, 1964, Italy.

A nuclear spectrometer system is described wherein a multichannel analyzer is provided with means for the normalization of the energy spectra with an apparatus which makes it possible to reduce two spectra to the same energy or amplitude scale. The system is designed for use in activation analysis. (W.H.K.)

49112 EXAMINATION OF NEUTRON SCATTERING BY MEANS OF DETECTOR BANKS. Konczos, Geza; Madarasz, Zoltan (Central Research Inst. for Physics, Budapest). Magy. Fiz. Foly., 16: 279-83(1968). (In Hungarian).

The reproducibility of the count rate of banks of BF_3-filled detectors, used in parallel, has been well investigated in the past; in order to make sure that instruments used to detect low-intensity neutron beams have identical characteristics, the performance of sets of counters was systematically compared. The tubes were filled with BF_3 to a pressure of 630 mm of Hg and were checked before use by means of a 0.1 C Po–Be source. The differential and integral amplitude and voltage spectrum of each instrument was measured, repeating the determinations with sets of 5 instruments in parallel. The results indicated that the differential amplitude spectrum is narrow; the parallel group behaved as a single counter tube. The differential spectrum pulses could be easily detected at a 108-v position of the discriminator, in the presence of α signals of an (m,α) reaction. The banks of counters were used in a neutron spectrometer. (TTT)

High Energy Physics Instrumentation

Refer also to abstracts 50486, 50491, and 50518.

49113 (ANL-Trans-668) PROGRAM OF GEOMETRICAL RECONSTRUCTION FOR BIG BUBBLE CHAMBERS (VARIANT 1-6). Markova, N. F.; Moroz, V. I.; Nikitina, V. I.; Stel'makh, A. P.; Tentyukova, G. N. (Joint Inst. for Nuclear Research, Dubna (USSR)). Translated by Elmar K. Wilip (Argonne National Lab., Ill.), from pp 1-26 of JINR-P10-3768. 16p. Dep. CFSTI.

The program of geometrical reconstruction for big bubble chambers is considered which takes into account inhomogeneity of the magnetic field, ionization losses and multiple scattering. The bremsstrahlung for electrons and positrons and its fluctuation is also considered. All the formulas used are well founded. The track parameters are determined using the maximum likelihood method by minimizing the functional χ^2 which takes into account the multiple scattering matrix and the radiation, if necessary. The function includes the calculated trajectory-integral of the Lorentz equation in a real magnetic field with the account of the losses. A good choice of the initial approximation allows to limit oneself by the iteration only, according to the Newton method while determining the final parameters which reduce χ^2 to the minimum. (auth)

49114 (CERN-68-34) WIRE STRETCHING MACHINE FOR SPARK CHAMBERS. Alleyn, H.; Guezennec, J. J.; Muratori,

G. (European Organization for Nuclear Research, Geneva (Switzerland)). Sept. 17, 1968. 12p. Dep.

The design and performance of a wire-stretching machine for fabricating very large wire spark chambers are discussed. The main beam and chariot, wire delivery unit, wire supporting frame, escapements, operation of the needles, and the control panel are described. (W.H.K.)

49115 (IS-T-265) COMPARISON OF DIFFERENT PROCEDURES FOR ITERATIVE FITTING OF BUBBLE CHAMBER EVENTS INVOLVING NEUTRAL PARTICLES. Baker, Paul Arthur (Ames Lab., Iowa). Aug. 1968. Contract W-7405-eng-82. 35p. Dep. CFSTI.

Thesis.

The new method has two versions. The two versions resulted from two different ways of doing the calculation of errors associated with variables computed in the iteration procedure. Version 2 did better than version 1 in attaining the desired goals. The undesirable feature of the old method of doing the kinematical analysis was that it obtained too many "fake fits." Version 1 reduced the number of "fake fits" by 67%. This reduction is helpful in easing the job of ion checking. However, due to the rigidity of error assignments, version 1 lost up to 32% of the real fits. This loss cannot be rationalized by the time savings associated with the computation in the iteration procedure and with the ionization check. Version 2 reduced the number of "fake fits" by 47% and at the same time retained at least 85% of the real fits. Although the reduction of "fake fits" by version 2 is not as great as that for version 1 the retention of real fits is better. During the experiments used to test the new method, version 2 represented a compromise between the leniency of the old method and the rigidity of version 1. In some cases the losses sustained by version 2 may be counterbalanced by the time savings obtained. For example, if the number of events expected for a desired final state is large, one could balance the 15% loss of fits with the reduction in time required to run the program on a computer. However, even a maximum 15% loss is not acceptable if one has a small number of fits. In that case the old method is preferable and the extra computation and ion checking time is necessary. (auth)

49116 ALPHA PARTICLE TRACK DETECTION WITH CELLULOID FILMS. Hasegawa, H.; Matsuo, M.; Yamakoshi, K.; Yamawaki, K. (Kyoto Univ.). Radioisotopes (Tokyo), 17: 419-22 (Sept. 1968).

The solid state track detector of celluloid films (cellulose nitrate + camphor 25% in weight) using etching technique was used for low energy alpha particle detection. The critical rate of energy loss for track formation in celluloid films was determined as 1.3 MeV/mg·cm^2. Irradiated samples were etched in NaOH (6N) solution at 46°C for 10 minutes. Etched tracks were observed under a view of optical microscope at magnification of 7 × 20 to 7 × 40. Under vacuum condition of 10^{-3} torr or at low temperature of −26°C no changes were observed in track formation. The feature of track fading phenomena is different in hot water and air. (auth)

49117 "STAN", A GEOMETRY PROGRAMME FOR HEAVY LIQUID BUBBLE CHAMBERS. Huybrechts, M. (Univ. Libre, Brussels). Univ. Brux., Inst. Phys., Bull., No. 36, 1-60(Apr. 1968).

The computer program, STAN, in FORTRAN for the reconstruction of heavy liquid bubble chamber events is described. In heavy liquids, the importance of single and multiple scattering makes it difficult to adjust a curve to a complete track, therefore, STAN calculates the estimates for the parameters characterizing the tracks from the coordinates of points of the tracks reconstructed in space without any adjustment of curves. The estimators are obtained by the maximum likelihood method. (W.H.K.)

49118 HYDROGEN DISCHARGE-CLOUD CHAMBER. Manjavidze, Z. Sh.; Javrishvili, A. K.; Roinishvili, V. N. (Inst. of Physics, Tbilisi, USSR). Phys. Lett., 27B: 539-40(Sept. 16, 1968).

A possibility of construction of a hydrogen discharge-cloud chamber is described. Due to control and the possibility of its exposure in beams of high intensity, a hydrogen discharge cloud chamber can be more effective than a hydrogen bubble chamber while studying events with small cross-sections. (auth)

49119 IMPROVEMENTS IN OBSERVATION OR PHOTOGRAPHY DEVICES IN CLOSED SPACES AND IN PARTICULAR IN BUBBLE CHAMBERS. (to Commissariat a l'Energie Atomique). British Patent 1,128,866. Oct. 2, 1968. Priority date Nov. 17, 1965, France.

A dioptrical device for observing and photographing the inside of an enclosure such as a hot cell, a nuclear reactor channel, a Wilson chamber, and, in particular, a bubble chamber is described. (W.H.K.)

49120 RECOGNITION OF GENERAL LINE PATTERNS WITH APPLICATIONS TO BUBBLE CHAMBER PHOTOGRAPHS AND HANDPRINTED CHARACTERS. Nir, Michael. Philadelphia, Univ. of Pennsylvania, 1967. 202p.

Thesis.

A general method for the recognition of drawings composed of line-like elements ("line patterns") is described. Generality is achieved by approximating any pattern presented for recognition (even if it includes closed loops) by a tree of straight line segments, which makes it possible to describe the structure of any pattern explicitly by a concise code which has been developed for this purpose. This description allows direct comparison of patterns and also the lexicographical ordering of the patterns. By entering the patterns which are acceptable in the class being considered into such an ordered list, or "dictionary," patterns which are similar in a certain sense are grouped together. This dictionary of "legal" patterns constitutes the rules of the grammar under which line segments are linked to form patterns. It not only indicates whether a certain explored configuration of line segments is acceptable, but also provides similar patterns in case it is not, so that the probable faults may be used to guide further processing. All the information characterizing this class is contained in the dictionary, the entries of which are all that has to be changed when patterns of a different class are presented for recognition. The system handles the input data as provided by the digitizing equipment, without any preprocessing. These input data, i.e., the basic description of the picture, are in the form of a list of coordinates of points on the edge of the lines of the patterns. The system has been experimentally implemented by a computer program which comprises approximately 1500 FORTRAN statements and can be accommodated in a 32K word memory. The input is a list of coordinates of points in the picture and the output specifies those dictionary entries which have been recognized in the picture, with the option of a list of the points which have been associated with each of these patterns. Of the many possible applications of this system, two have been successfully tested: (a) The automatic processing of bubble chamber photographs, digitized by a Flying Spot Digitizer, the purpose of which is to select those photographs in which interesting events seem to occur, and to provide a rough description of the pattern and its location in the frame, which facilitates the ensuing exact measurement of the tracks. (b) The recognition of handprinted characters, digitized by similar equipment. The limited experience gained so far with the recognition system indicates the feasibility of designing a working system which can recognize patterns of many classes by simply switching in the appropriate dictionary for each case. (Disser. Abstr.)

49121 EVENT SELECTION IN BUBBLE CHAMBER DATA ANALYSIS. Martin, H. J. (Indiana Univ., Bloomington). Nucl. Instrum. Methods, 64: 184-8(Sept. 15, 1968).

A method for establishing event selection criteria in bubble chamber experiments is described. Each event is represented by a point (P_n, W_n) where P_n and W_n are the missing energy and momentum for a given reaction hypothesis. The acceptable values of (P_n, W_n) for different reactions can be defined and the distribution of events studied to resolve ambiguities between reactions and to establish selection criteria. (auth)

49122 PROCESS TO INCREASE THE EFFICIENCY OF ARGON-FILLED SPARK CHAMBERS. Ion, I. X. (Inst. of Atomic Physics, Bucharest). Stud. Cercet. Fiz., 20: 299-300 (1968). (In Rumanian).

Use of neon as the medium for the propagation of streamers in a spark chambers presents several advantages, however, this material is costly. Therefore, experiments were carried out to find a less expensive medium. Results of the experiments indicated that chambers filled with argon at a reduced pressure exhibit excellent properties for the simultaneous detection of particles. Reduction of the pressure below the atmospheric level results in the lowering of the Townsend coefficient α, or in the increase of the breakdown resistance. This makes it possible to distribute the electric charge of the generator on several spark discharge channels. A reduction of the argon pressure from −0.1 to −0.2 atm was found to improve the efficiency of the chamber in 80% of the cases. (TTT)

49123 VIDICON FOR SPARK CHAMBER DATA AUTOMATIC TELEVISION READOUT. Petrakov, A. V.; Gorokhov, V. P. Izv. Akad. Nauk Arm. SSR, Ser. Fiz., 3: No. 1, 32-5(1968). (In Russian).

The characteristics of an LI-415 vidicon for microsecond light pulse operating conditions are studied with the aim of using it for spark chamber data automatic television readout. The light-transfer characteristic, as well as the accumulation and persistence characteristics are given. (auth)

49124 EFFECTS OF THE ALCOHOL VAPOR ON THE OPERATING CHARACTERISTIC OF THE SPARK CHAMBERS. Akopyan, G. S.; Marikyan, G. A. (Inst. of Physics, Erevan). Izv. Akad. Nauk Arm. SSR, Ser. Fiz., 3: No. 1, 42-8(1968). (In Russian).

The operation of the spark chamber with various gas mixtures was investigated. The dependence of the cosmic ray charged particle registration efficiency on the total number of the particles already registered and upon the time passed after filling the chamber with gas is determined. The measurements were carried out for various delays (1.5–50 μ sec) between the passage of the particle through the chamber and the high voltage pulse supply. It is found that when saturated alcohol vapor is mixed with the especially pure neon, the quality of the tracks improves and coincide with the real particle trajectories more correctly. (auth)

49125 FIRST USES OF A STREAMER TYPE SPARK CHAMBER. Benaksas, D. (Stanford Univ., Calif.). Rev. Phys. Appl., Suppl. J. Phys., 3: 99-106(June 1968). (In French).

The results of a series of tests carried out on a spark chamber used in the streamer mode are presented. The great advantages of this new technique are shown. (auth)

Radiation Dosimeters

Refer also to abstract 50791.

49126 (CLOR–68) PERSONNEL FILM MONITORING AND THE EVALUATION OF EXPOSURE TO IONIZING RADIATION OF THE MONITORED PERSONS IN POLAND IN THE YEAR 1966. Kucharski, M.; Musialowicz, T.; Jasiak, J.; Wysopolski, J. (Centralne Laboratorium Ochrony Radiologicznej, Warsaw (Poland)). 1968. 17p. (In Polish). Dep.

The results of a personnel film monitoring program carried out by the Central Laboratory for Radiological Protection (CLOR), in the year 1966 is described. The number of monitored persons in 1966 amounted to 4946 in 197 establishments. The number of overdoses which occurred in monitored persons decreased in comparison with the previous years, mainly in industry. This was probably due to less use of luminous paints containing Ra-226. The results from CLOR have been compared with similar ones from National Institute of Radiation Protection, Stockholm. (auth)

49127 (ORO–3343-2) [THE DOSIMETRY AND RADIOBIOLOGY OF NEGATIVE PIONS]. IV. WORK ACCOMPLISHED. Richman, Chaim; Raju, M. R.; Feola, J.; Barendsen, G. W. (Southwest Center for Advanced Studies, Dallas, Tex.). June 25, 1968. Contract AT(40-1)-3343. 25p. Dep. CFSTI.

Meson (π^-) dose distribution in water at 65 and 91 MeV, dose distribution in silicon detectors at 65 MeV, and the differential range in Lucite at 67 and 91 MeV are presented graphically. Also, integral dose distribution curves are given for 65-MeV meson (π^+) beams in a silicon detector. (W.H.K.)

49128 COMPRESSED LITHIUM FLUORIDE DOSIMETER PELLET. Shambon, A. (to United States Atomic Energy Commission). U. S. Patent 3,402,293. Sept. 17, 1968.

A method is described for preparing a dosimeter consisting of a pellet of LiF compressed in a binder of sodium silicate at a pressure in excess of 18,000 psi. (AEC)

49129 IONIZATION CHAMBER. Betchen, Georges; Joffre, Henri; Herrero, Jose Mallen (to Commissariat a l'Energie Atomique). British Patent 1,123,267. Aug. 14, 1968. Priority date Nov. 16, 1965, France.

The design of an ionization chamber for personnel dosimetry of beta, gamma, and x radiation is presented. The chamber wall is formed of an alloy of beryllium with at least one of the elements aluminum, magnesium, or silicon. The proportion of beryllium used is such that the coefficient of response to beta, gamma, and x radiation is substantially identical with the coefficient of response of air, which is used as the filling gas. (W.H.K.)

49130 THERMOLUMINESCENCE RESPONSE OF CaF_2:Mn IN POLYTETRAFLUOROETHYLENE TO ELECTRONS. Ehrlich, Margarete; Placious, Robert C. (National Bureau of Standards, Washington, D. C.). Health Phys., 15: 341-50(Oct. 1968).

Foils of powdered CaF_2 : Mn in polytetrafluorethylene, with thickness from 15 to 150 μm, were exposed to monoenergetic electrons having energies in the region between 20 and 400 keV. The thermoluminescence response of the foil was studied as a function of the energy and the fluence of the incident electrons, the foil thickness, and the electron energy absorbed in the foils. The dependence on electron energy of the response per unit fluence was found to change considerably with foil thickness, the maximum response occurring at approximately the energy of the incident electrons whose ranges are equal to the thickness of the foil layers. From the lowest incident-electron energy employed (20 keV) up to this energy (200 keV for the 150 μm layer), response per unit fluence increased linearly with electron energy. Response per unit energy fluence (in this energy range approximately equal to total energy absorbed in the foils) was independent of the energy of the incident electrons, at least within the large error of the experiment. The response per unit of electron energy absorbed also agreed, within the limits of experimental error, with that obtained for foils exposed to ^{60}Co gamma radiation. (auth)

49131 LONG-TERM STABILITY OF RADIOPHOTOLUMINESCENCE IN METAPHOSPHATE GLASS. Cheka, J. S. (Oak Ridge National Lab., Tenn.). Health Phys., 15: 363-8(Oct. 1968).

Continuing studies are reported on three types of metaphosphate glass, including the use of modified testing techniques. Results are shown graphically. An interesting result is that each type of glass shows a greater fluorescence stability than could have been surmised from the earlier data. This stability suggests the feasibility of a lifetime dosimeter, especially since small repeated exposures were found to be additive. It is emphasised, however, that the specimens were stored in an air-conditioned laboratory and that the range of variation in uncontrolled ambient temperatures would probably be somewhat larger. (U.K.)

49132 PULSE READ ION CHAMBER SYSTEM. Braby, L. A. (Battelle Memorial Inst., Richland, Wash.). Contract AT(45-1)-1830. Health Phys., 15: 351-6(Oct. 1968).

A method of reading capacitor ion chambers using fast pulse electronics was developed. This system can read commercial pencil chambers to 10 mV over a range of 0–20 V. A tissue equivalent ion chamber 3.6 cm long and 1.2 cm in dia. was designed and found to operate reliably when used in conjunction with this reader. The combination will measure neutron and gamma doses of less than 1.5 rad to ±15 per cent with a minimum sensitivity of 0.05 rad. The dosimeter system has been successfully used for in-phantom neutron dose distribution measurements. (auth)

49133 THERMOLUMINESCENT RESPONSE OF LITHIUM FLUORIDE TO RADIATIONS WITH DIFFERENT LET. Suntharalingam, Nagalingam. Madison, Wis., Univ. of Wisconsin, 1968. 126p.

Thesis.

The supralinear thermoluminescent response of LiF (TLD-100) has been investigated in detail using monoenergetic electrons over a wide range of energies. In the low energy region, electrons from 50 to 400 keV were used. Experiments were also performed using high energy electrons from 6 to 33 MeV. The results of the dose response studies indicated the higher LET radiations as causing less supralinearity. Also, the high energy electron irradiations showed a response identical to the Cesium-137 gamma radiation These two types of radiations have almost equal values for the LET or mean stopping power in lithium fluoride. More evidence for the LET dependence was obtained from studies on the increase in sensitivity as a function of previous dose. Measurements of the sensitivity factor, a measure of the increase in sensitivity, showed a pronounced dependence of the quality or LET of both the sensitizing and the test radiations. Low LET radiations gave a high sensitivity factor at doses greater than 10^4 rads and as the LET increased this sensitivity factor decreased. The LET dependence of the TL response was further verified using high LET 4.4 MeV deuterons. No supralinearity was seen from these irradiations, the response remaining linear to 10^5 rads. From the studies reported it is concluded that there are now four different radiation quality dependent effects in the thermoluminescence of lithium fluoride: (1) the usual low energy increase in photoelectric cross-section, (2) the decrease in supralinearity with increase in LET, (3) the decrease in the response of sensitized phosphor with increase in LET and (4) increase in efficiency at low doses with increase in LET. The LET dependence of both the supralinearity and increase in sensitivity suggests the possibility that a TL phosphor with large supralinearity might serve as a "LET meter." (Disser. Abstr.)

49134 CALIBRATION OF A PORTABLE GAMMA-RAY SPECTROMETER. Gibson, J. A. B.; Burt, A. K. (United Kingdom Atomic Energy Authority, Harwell, Eng.). Health Phys., 15: 333-40(Oct. 1968).

The methods of determining the spectrometer channel width, peak width and peak-to-total efficiency are described. The calibration was carried out with standard sources and a multichannel analyzer. The results were compared with data from other workers and reasonable agreement demonstrated. The conversion

of peak height to photon flux or dose is obtained from a series of graphs obtained by calibration or, less accurately, from a nomogram. The spectrometer (E.A.L. type no. NIS 292) is used for survey around nuclear installations. (auth)

49135 NEUTRON ENERGY DEPENDENCE OF EXCESS CHARGE CARRIER LIFETIME DEGRADATION IN SILICON. Speers, R. R. (Ohio State Univ., Columbus. Phylatron Corp., Columbus). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-15: No. 5, 9-17(Oct. 1968).

Silicon p-i-n diode-neutron dosimeters were irradiated with monoenergetic neutrons having energies from 0.36 to 4.77 MeV. The variation with neutron energy of the damage coefficient for diode storage time, $\alpha_T = \Delta(1/T_s)/\varphi$, and diode forward voltage sensitivity at constant current, $S = \Delta V_f/\varphi$, were determined and found to be equal. Since α_T and S are linearly related to the damage coefficient for high level lifetime, $\alpha_\tau = \Delta(1/\tau)/\varphi$, the variation with neutron energy of α_τ was also determined. Theoretically, it has been hypothesized that α_T is proportional to $\overline{N}_r(E_n)$, the average number of active recombination centers added per cm^3 per neutron of energy E_n incident per cm^2. It was further hypothesized that $\overline{N}_r(E_n)$ is proportional to $\overline{E}(E_n)$, the average energy given to lattice atoms per cm^3 per neutron of energy E_n incident per cm^2. The theory of Lindhard, Nielson, Scharff, and Thomsen, together with published values for differential neutron-silicon scattering, was used to calculate $\overline{E}(E_n)$. Comparison of theoretical and experimental results shows that α_T, S, and $\overline{E}(E_n)$ do indeed have substantially the same neutron energy dependence. (auth)

Radiometric Instruments

Refer also to abstracts 49034 and 49402.

49136 STUDIES ON THE EFFECT OF THE SILVER UNDERCOAT ON THE THICKNESS MEASUREMENTS OF GOLD COATINGS BY THE β-REFLECTION METHOD. Sekowski, S. (Inst. of Precision Mechanics, Warsaw). Nukleonika, 13: 941-7(1968). (In Polish).

The effect of the thickness of the silver undercoat on the determination of the gold coating thickness by radioisotopic methods is analyzed, and a method for measuring the thickness of gold coatings on unknown silver undercoats is described. Experimentally determined corrections providing for the shift of the zero point are also given. (auth)

49137 INFLUENCE OF THE AIR-GAP ON SURFACE DENSITY GAUGE. Uemura, Teiji (Industrial Research Inst., Osaka Prefecture). Jap. J. Appl. Phys., 7: 1267-73(Oct. 1968).

Calculations for the single scattering of gamma-rays were made in the case where the surface density gage was apart from the material surface. Conditions in which the relative error in density caused by the presence of the air-gap was small were inferred from the calculations by assuming several geometrical factors. From these calculations and experiments, it was evidently seen that the relative error was small in the cases where the solid angle of the incidence of gamma rays was small and where the separation distance between the source and the detector was enlarged. If the separations expressed in the mean free path for the different source energies were kept equal, the relative error was also small in the case of the high energy source. The measurements of wet densities were made on the rammed soils of two types by using a gauge of the backscatter type, compared with one of the transmission type. (auth)

49138 DETERMINATION OF OXYGEN IN SURFACE FILM BY IRRADIATION WITH TRITONS OF 3 MeV. Barrandon, J. N.; Albert, Ph. (Centre d'Etudes de Chimie Metallurgique, Vitry-sur-Seine, France). Rev. Phys. Appl., Suppl. J. Phys., 3: 111-15(June 1968). (In French).

The excitation function of the reaction $^{16}O(t,n)^{18}F$ has been determined when the triton energy varies from 0.5 to 3.0 MeV. Additionally, a method is presented for the determination of metal oxide film thickness by triton irradiation. (auth)

Miscellaneous Instruments and Components

Refer also to abstracts 49326, 50802, and 50900.

49139 (AERE-M-2077) DECUR 5: A PDP-8 PROGRAMME FOR PROCESSING DATA FROM SCALERS PUNCHED ON PAPER TAPE. Cuninghame, J. G. (Atomic Energy Research Establishment, Harwell (England)). June 1968. 52p. Dep. CFSTI. UK 8s. 0d.

A program for the 4K PDP-8 computer which accepts punched paper tape containing decay curve information from scalers is described. The program sorts the information out and reproduces it, either as tapes in a format suitable for further processing in a large computer, or as a printed record of calculated counts per minute corrected for counter background and paralysis, together with the calculated mid-point of the count. These data are therefore ready for plotting a decay curve directly. (auth)

49140 (CONF-660553-11) APPARATUS FOR MEASURING THE PHYSICAL PROPERTIES OF LIQUID ORGANIC HEAT TRANSFER MEDIA. Elberg, S.; Bessouat, R.; Chavanal, H.; Courtaud, M. ([Commissariat a l'Energie Atomique, Grenoble (France). Centre d'Etudes Nucleaires]). [1965]. 29p. (In French). Dep.

From Panel on Use of Organic Liquids as Reactor Coolants and Moderators, Vienna, Austria.

Devices were developed for the measurement up to 500°C under a pressure up to 20 kg/cm^2 of the density, viscosity, specific heat, thermal conductivity, vapor tension, and solubility of gases in liquids. The devices were constructed specially for the study of polyphenyls and were designed for simplicity, easy cleaning, elimination of stuff joint, and reduction of the number of air-tight joints. The design principles of the devices are outlined. Typical results obtained are reported as examples. (J.S.R.)

49141 (IN-1214) INTRODUCTORY COMPUTER PROGRAMS FOR NEUTRON DIFFRACTION. Boyter, J. K.; Brugger, R. M. (Idaho Nuclear Corp., Idaho Falls). Aug. 1968. Contract AT(10-1)-1230. 76p. Dep. CFSTI.

A series (6) of procedures for processing data generated by the MTR Time-of-Flight Diffractometer are described. Five of these procedures—4 crystallographic and 1 for calculating constants for the diffractometer—are programmed in FORTRAN 63 for the CDC 1604 computer. The sixth procedure is a scheme for calculating the Debye-Waller Factor of a crystal. (auth)

49142 (INR-917) NONOVERLOADING LINEAR PULSE AMPLIFIER. Bayer, Ryszard; Koba, Teresa (Institute of Nuclear Research, Warsaw (Poland)). 1968. 19p. (In Polish). Dep.

A non-overloading linear pulse amplifier was built. Its operation principle, solution and characteristics are described. Some results of measurements are given. (auth)

49143 (MLM-1554) MODIFIED MOISTURE ANALYZER FOR SOLID RADIOACTIVE MATERIALS. Kreider, H. B. Jr. (Mound Lab., Miamisburg, Ohio). Sept. 13, 1968. Contract AT-33-1-GEN-53. 8p. Dep. CFSTI.

Modifications to a commercially available, high temperature moisture analyzer have permitted moisture contents of radioactive samples to be determined without exposing either the operator or the electronic components of the instrument to radioactivity. Performance of the analyzer continues to meet the accuracy specifications of the manufacturer. (auth)

49144 (RISO-173) DIGITAL DATA XY PLOTTER WITH DATA SORTING CAPABILITIES. Hansen, K. B. (Danish Atomic Energy Commission, Risoe. Research Establishment). Apr. 1968. 25p. Dep.

The digital data XY plotter described is used as an output unit in digital instrumentation systems. Identifying characters in the serial by character output from the systems are used to sort out the data to be plotted. The numerical characters are assembled in a shift register, transferred to a buffer register and converted to the analog form. The recorder is a conventional XY analog plotter with zero detector. (auth)

49145 (SLAC-88) AN ANALYSIS OF TRANSIENTS IN TUNNEL-DIODE CIRCUITS. Barna, Arpad (Stanford Linear Accelerator Center, Calif.). Aug. 1968. Contract AT(04-3)-515. 46p. Dep. CFSTI.

An analysis is performed for the transient response of a tunnel-diode modeled by a circuit of two capacitances, an inductor, and the dc i-v characteristic of the diode. The nonlinear differential equations of the transition are solved numerically, and waveforms are presented for a wide range of circuit parameters. (auth)

49146 (UCRL-18378) MAGNETIC FIELD COMPUTATION FOR TWO-DIMENSIONAL AIR COIL SYSTEM. Yourd, Roland; Halbach, Klaus (California Univ., Berkeley. Lawrence Radiation Lab.). July 1968. Contract W-7405-eng-48. 30p. Dep. CFSTI.

Analytic formulas suitable for numerical computation are derived for two-dimensional air coil systems. The computer code,

FIELDS, is described, and evaluation of a sextupole magnet is included as a sample problem. A complete listing of the program coding is also provided in an appendix. (auth)

49147 (UCRL-18410) LOW TEMPERATURE STAGE FOR THE PICKER THETA-THETA X-RAY DIFFRACTOMETER. Nembach, Eckhard (California Univ., Berkeley. Lawrence Radiation Lab.). Aug. 1968. Contract W-7405-eng-48. 10p. Dep. CFSTI.

A cold stage for the Picker Theta-Theta X-ray Diffractometer, Model 3488K, was constructed to measure lattice constants of powder specimens at 91°K. (auth)

49148 (UNC-5223) A CONTINUOUS ELECTROCHEMICAL METER FOR MEASUREMENT OF HYDROGEN IN SODIUM. Progress Report, April 1, 1968-June 30, 1968. (United Nuclear Corp., Elmsford, N. Y. Research and Engineering Center). July 31, 1968. Contract AT(30-1)-3908. 32p. Dep. CFSTI.

Twelve experimental electrochemical hydrogen sensors were subjected to systematic gas tests in argon-hydrogen mixtures at temperatures ranging from 370 to 650°C, with encouraging results. It was found that the sensors did respond to hydrogen in conformance with a simple concentration cell model involving hydrogen transfer by hydride ion validating the sensor concept. Sensors having liquid electrolytes consisting of alkali hydrides dissolved in LiCl-KCl eutectic and gas reference electrodes operating with 5% hydrogen-95% argon exhibited near theoretical voltages at 370°C. Work on the sodium testing task was initiated. (auth)

49149 COLOR AUTORADIOGRAPHY. I. NEW TYPE OF COLOR FILM AND APPLICATION TO DOUBLE-TRACER MACROAUTORADIOGRAPHY. Shindo, Hideyo (Sankyo Co., Ltd., Tokyo); Nakajima, Eiichi; Kuwabara, Yoshimi; Hirata, Akira; Sugita, Sadao. Radioisotopes (Tokyo), 17: 433-40(Sept. 1968). (In Japanese).

To distinguish the distribution of double tracers, tritium and any other β-emitters, on the same autoradiogram, a special type of two-layer emulsion with incorporated different color coupler was introduced. Thirty two kinds of film with different sensitivity and thickness of the layers and different couplers were prepared to find a suitable set. According to the difference in energy, tritium colored the film in cyan, while any other β-emitters in red (Type 24) or in yellow (Type 32). In film Type 29, ^{3}H colored it in cyan, ^{14}C in green, and ^{32}P in yellow, providing a possibility of distinction of three nuclides. Applications of these films for identification of nuclides on thin-layer chromatogram and for tracing the distribution of double tracers in whole body autoradiography are shown. A possibility of quantitative determination of two nuclides with densitometry is also discussed. (auth)

49150 RESPONSE FUNCTIONS AND MEASUREMENT OF LINE SPREAD FUNCTIONS IN γ-RAY RADIOGRAPHY. Nojiri, Toshiaki; Aonuma, Keisuke; Ohno, Akira. (Industrial Research Inst., Yokohama, Japan). Radioisotopes (Tokyo), 17: 428-32 (Sept. 1968). (In Japanese).

The measurement of line spread functions for the combinations of certain x-ray films and lead foil screen in industrial γ-ray radiography was studied to get spatial frequency responses of such combinations. Assuming that the line spread function is expressed by Gaussian curve and applying a simple correcting equation for slit width, the line spread function for γ-ray beams incident on the test film and having an intensity distribution expressed by Dirac's delta function was determined. Response functions and the true line spread functions for the combinations of x-ray film and ^{60}Co, ^{137}Cs, and ^{192}Ir sources are shown. By the calculation from the normalized line spread function, the inherent unsharpness defined by step edge image is also shown. As a result, the unsharpness values of 280, 230 and 160 microns were obtained, respectively, for ^{60}Co, ^{137}Cs and ^{192}Ir. (auth)

49151 MULTI LENS SPECTROHELIOGRAPH FOR NON-STABILIZED ROCKETS. Oehman, Yngve (Stockholm Observatory, Saltsjoebaden, Sweden). Ark. Astron., 4: 465-70(1968).

A spectroheliograph is described, consisting of a great number (85) of small quartz lenses (aperture 4 mm) placed on the curved surface of a spherical segment. All the lenses have exactly the same focal length (100 mm), this focal length being also the radius of curvature of the spherical segment. In the center of curvature a small reflecting sphere is placed (with a diameter of 0.5 mm). From a small area of the sphere the rays are reflected sideways towards the f/6 collimating lens of a short dispersion quartz spectrograph, where the spectrum of the sun is recorded on a continuously moving film. An instantaneous exposure selects an apparent area of the solar image of less than one square minute of arc. By the spin of the rocket a recording is obtained of consecutive points along a chord of the solar image. Then by chance another lens gives a recording along another chord and so on. During a flight time of about two minutes a fairly complete scanning of the solar surface may be expected. The recording time indicated by the width of the spectral image will be a measure of the length of the chord. In this way an identification of the regions on the sun may become possible. The instrument is intended for the study mainly of the Mg II lines at 2800 Å and particularly in solar flares. In order to facilitate the identification of the chords the lenses on the spherical segment may be combined with small objective prisms giving the same dispersion as the prism of the spectrograph. In this way circular solar images may be photographically recorded. With such a double monochromator the solar disk is imaged in a limited range of wavelength. With the proper setting the spectral lines will be seen as chords in the image. This will greatly facilitate the identification of plages, etc., visible in the lines. A multilens without prisms was made and tested with success. Very promising experiments were made also with a double monochromator using a reflecting sphere as slit. Circular images are obtained without difficulty when scanning the image by means of a rotating plane-parallel glass plate. These experiments are described. (Sweden)

49152 APPARATUS FOR WEIGHING OUT A PREDETERMINED WEIGHT OF MATERIAL. Allsopp, Peter James (to United Kingdom Atomic Energy Authority). British Patent 1,129,046. Oct. 2, 1968. Filed Aug. 4, 1966,

An automatic balance, which repeatedly weighs a predetermined amount of material and dumps it, is described. The weight pan is suspended from a piston which is moveable in a cylinder in which pneumatic switches are designed to control the weighing cycle. The system was specifically designed to weigh 10 to 30 gram batches of uranium dioxide powder. (W.H.K.)

49153 ULTRASONIC INTERFERENCE MICROMETER. Davey, C. N. (Atomic Energy Research Establishment, Harwell, Eng.). Ultrasonics, 6: 103-6(Apr. 1968).

In nuclear reactors, thicknesses of the walls of tubes are measured by two ultrasonic instruments, the continuous wave micrometer and the pulsed wave micrometer. The principles and recording techniques of the instruments are described. The continuous wave micrometer is used for simultaneous determination of thicknesses during defect-testing operations, while the pulsed wave instrument is preferred when better surface discrimination is needed. (auth)

49154 WINDOW DISCRIMINATOR WITH INTEGRATED CIRCUITS. Sattler, E. (Central Bureau for Nuclear Measurements, Geel, Belg.). Nucl. Instrum. Methods, 64: 221-4(Sept. 15, 1968).

Some design criteria for a window discriminator with integrated circuits are outlined. The realized unit has a dynamic range from 10 mV to 10 V. The minimum input pulse width is less than 100 ns. (auth)

49155 PAPER-TAPE DATA HANDLING FOR A COSMIC RAY EXPERIMENT. Cohn, C. E. (Argonne National Lab., Ill.). Nucl. Instrum. Methods, 64: 225(Sept. 15, 1968).

A low-cost data recording system was developed for a two-parameter cosmic-ray experiment of low event rate. The computer programming and equipment design were closely coordinated. (auth)

49156 SECOND STAGE NOISE CONTRIBUTION OF NUCLEAR PULSE AMPLIFIER. Arbel, Arie F. (Israel Inst. of Tech., Haifa. Israel Atomic Energy Commission, Tel-Aviv). IEEE (Inst. Elec. Electron. Eng.), Trans, Nucl. Sci., NS-15: No. 5, 2-5(Oct. 1968).

The noise contribution P of the second stage relative to that of the preamplifier is derived as a function of its own noise parameters, the noise parameters and gain of the preamplifier, and the elements R_0C_0 of the coupling network. Design criteria are derived, for the second stage either preceding or following the short differentiator. For the latter case it is shown, that a lower limit exists for P if C_0 is greater, and R_0 is smaller than a certain critical value. The resulting time-constant R_0C_0, for which that lower limit is obtained, is considerably shorter than the shaping time constant T. Hence, P may be reduced if the detector current impulse is recovered from the preamplifier output step by choosing $R_0C_0 \ll T$, and if shaping is postponed to a later stage. A short discussion of the implications which these considerations have upon the design of the amplifier stage following the first differentiator is given. (auth)

49157 PULSE ENERGIZING AND ENERGY RECOVERY SYSTEM FOR AN ELECTROMAGNET. Cole, John L.; Muray, Julius J. (to United States Atomic Energy Commission). U. S. Patent 3,405,327. Oct. 8, 1968.

A system for pulse energizing an electromagnet having a single winding is described wherein by switching a current source to charge, a capacitor is charged from a current source to a first

voltage level at a first polarity, reversing the charge on the capacitor by switching it from one capacitor plate to the other through an inductance and clipping the voltage across the inductance at a precise second level that is lower in magnitude than the first level, and then applying the reversed charge to the electromagnet winding to simultaneously energize the electromagnet and partially recharge the capacitor in the direction of the first polarity. (AEC)

49158 TIME SAMPLING CIRCUIT FOR AN OSCILLOSCOPE. Lefevre, Harland W.; Wieber, Donald L. (to United States Atomic Energy Commission). U. S. Patent 3,406,313. Oct. 15, 1968.

An oscilloscope circuit for displaying the waveform of very rapid, repetitive signals by time sampling is described. A fast ramp signal added to each input pulse is applied across a tunnel diode. The tunnel diode is back biased by a very slowly changing ramp signal. An X-deflection signal for an oscilloscope is derived in a time-to-height converter with an amplitude proportional to the time from the start of each input pulse until the tunnel diode conducts while Y-deflection is obtained from the slow ramp signal. The input signal waveform may be displayed as a line of dots. (AEC)

49159 TRANSDUCER FOR MEASURING PRESSURE PULSES. Lombard, David B.; Power, D. V. (to United States Atomic Energy Commission). U. S. Patent 3,404,559. Oct. 8, 1968.

A transducer apparatus having a convex dielectric surface nested between and insulating two conductors across which a potential is developed by shock waves impinging on the dielectric surface is described. (AEC)

49160 METODY REGISTRATSII I OBRABOTKI DANNYKH I YADERNOI FIZIKE I TEKHNIKE. (Recording and Data Processing Techniques in Nuclear Physics and Technology). Matalin, L. A.; Narai, Zh.; Chubarov, S. I. Moscow, Atomizdat, 1968. 573p.

The principle characteristics of recording and experimental data processing techniques are reviewed. The first chapter deals with experimental devices used in nuclear physics (detectors, radiation sources, particle selectors, and other measuring devices). Methods of recording and processing radiation detector data (signals, statistical distribution, various types of analyzers, and correlation methods) are discussed in the second chapter. Multichannel analyzers are covered in the third chapter. The fourth and fifth chapters deal with the design and operation of computers and various methods of programming as well as the uses of computers for nuclear measurements. (928 references are included). (R.V.J.)

49161 METHOD OF LOCATING THE AXIS OF A MAGNETIC FIELD FOR ELECTRON-BEAM FOCUSING. Nishihara, H.; Terada, M. (Osaka Univ.). J. Appl. Phys., 39: 4573-80 (Sept. 1968).

A quick and accurate method of locating the axis of a magnetic field of rotational symmetry is proposed. It is shown that the deviation of the field axis in direction or in position from the axis of a reference frame (the instrument axis) is found from the angular distribution of the transverse field component. This is detected by rotating a Hall probe on the instrument axis. Formulas for locating the axis of a uniform magnetic field and that of a periodic one for electron-beam focusing are derived, and have been experimentally confirmed. The instrument for the measurement is easily constructed, and the procedures are so simple that results can be obtained in a short time. Moreover, this can be done with error of less than a few percent and with resolution of the order of 10^{-4} rad in direction in case of uniform fields and of 10^{-4} in position (ratio to the inner radius of a magnetic field device) in case of periodic fields. (auth)

49162 METHOD FOR OBTAINING LARGE NUMBERS OF MEASURED TIME INTERVALS IN RADIOACTIVE DECAY. Garfinkel, S. B.; Mann, W. B. (National Bureau of Standards, Washington, D. C.). Int. J. Appl. Radiat. Isotop., 19: 707-9(Sept. 1968).

It is generally assumed that radioactive decay is a statistical process with a Poisson distribution. Previous data used to check this assumption were somewhat laboriously collected and limited in number. With the advent of multichannel and multiscaler analyzers it is possible to acquire vastly increased data. The collection of more than a quarter of a million measured intervals of time between consecutive α-particle emissions in a given solid angle, in groups of 389 events is described. Three methods of using a multichannel analyzer with a multiscaler mode to determine the time distribution of radioactive decay are described. Some experimental work is described using a method in which time is measured in terms of pulses at some standard frequency, the pulses being stored in the analyzer in the multiscaler mode, and switching from one channel to the next every time an α-particle is detected. ^{241}Am source provided the α-particles emitted at random intervals. The time intervals between successive α-particle detections were recorded as numbers in the memory. The mode of operation is described in detail. (UK)

49163 SQUARE ROOT DISPLAY WITH A SMALL COMPUTER. Best, G. C. (Atomic Energy Research Establishment, Harwell, Eng.). Nucl. Instrum. Methods, 64: 171-2(Sept. 15, 1968).

A simple method for square-root display is suggested in which the data are collected directly in square-root form, avoiding the complicated linear to square-root conversion. (auth)

49164 RECONDUCTIBLE PULSE FORMER. Van Zurk, R.; Sentis, G.; Bernard, P. (Centre d'Etudes Nucleaires, Grenoble, France). Nucl. Instrum. Methods, 64: 121-31(Sept. 15, 1968). (In French).

A reconductible pulse former, having a resolving time of 10 ns is described; the width of the shaped pulse is adjustable between 100 ns and 2 μs. The purpose of this shaping unit is to obtain in anticoincidence arrangements a gating efficiency of 100%, even at high counting rates. On the other hand this circuit can act, in a simple disposition, as an isolated pulse selector and can solve certain pile-up rejection problems. The operation of the device is described and some examples of its use are given. (auth)

49165 STATISTICAL EVALUATION OF SWITCHING CIRCUIT CHARACTERISTIC PARAMETERS. Abbattista, N. (Istituto di Fisica, Bari, Italy); Coli, M.; Giannelli, G.; Plantamura, V. L. Nucl. Instrum. Methods, 64: 205-7(Sept. 15, 1968).

The problem of correlating the threshold and switching delay with the statistical characteristics of the noise is approached in a statistical way. (auth)

49166 ADVANCED MODULAR SYSTEM OF NUCLEAR ELECTRONICS FOR ON-LINE COMPUTER APPLICATIONS. Becker, W. (Euratom-CCR, Milan). Nucl. Instrum. Methods, 64: 197-200(Sept. 15, 1968).

A prescribed method for associating transducers on-line with computers has been defined by collaboration between major nuclear laboratories in Europe, acting under the auspices of the ESONE committee. (auth)

49167 DIGITAL MULTIPLIERS FOR CORRELATION MEASUREMENTS. Tiberio, P. (Istituto di Elettronica, Pisa). Energ. Nucl., 15: 661-5(Oct, 1968). (In Italian).

Some schemes of recently developed fast multipliers are presented, which have been found particularly suitable for few bits correlation measurements. A comparison is performed among them, with regard to their cost given as the number of integrated circuits needed and the time necessary for the computation. (auth)

49168 CROSS-WIRE DIGITIZED AND TELEMETERING EYEPIECE FOR MEASUREMENTS IN A NUCLEAR EMULSION. Volmer, Pierre; Christophel, Edmond (CRN, Strasbourg). Rev. Phys. Appl., Suppl. J. Phys., 3: 116-18(June 1968). (In French).

A cross-wire eye-piece is described in which both perpendicular motions are digitized and controlled by a joy stick through electric motors. The coordinates of a point in the image given by the objective are punched out on a paper tape. They can be measured with accuracy better than the size of a grain in the nuclear emulsion. (auth)

49169 DESCRIPTION OF AN APPARATUS FOR CENTRAL SCATTERING OF X RADIATION FOR USE AT LOW TEMPERATURES. Naudon, A.; Jaulin, M. (Laboratoire de Metallurgie Physique, Poitiers, France). Rev. Phys. Appl., Suppl. J. Phys., 3: 152-6(June 1968). (In French).

An apparatus for measuring small angle x-ray scattering using monochromatic radiation using a precise goniometer and a proportional counter is described. Scattering given by low temperature ageing of metallic samples can be measured on an absolute scale. The originalities of this apparatus are the facility for mechanical regulation and the system of sample-cooling by vacuum conduction. Circulation of methanol controlled by a four way gate connected on two cryostats permits the ageing without removing the sample. (auth)

49170 RESPONSE OF A PHOTODETECTOR TO SHORT SIGNALS. Papoular, R. (EURATOM-CEA, Fontenay-aux-Roses, France). Rev. Phys. Appl., Suppl. J. Phys., 3: 169-74(June 1968). (In French).

The photodetector considered comprises a photomultiplier and an RC circuit. The time response of this device is computed for different common shapes of light signals. This leads to a procedure for the determination of the essential parameters of the

detector. The influence of shot effects on transient and permanent regimes is considered. Also discussed are some of the rules for the interpretation of the detector response to an unknown signal. (auth)

49171 METHOD AND DEVICE FOR ADJUSTING AND MAINTAINING A PRESET GAS PRESSURE IN CLOSED VESSELS. Schmidt, Albrecht; Dohrmann, Albrecht (to Gesellschaft fuer Kernforschung MBH). British Patent 1,127,755. Sept. 18, 1968. Filed Nov. 25, 1965.

The device is connected to the sealed gas discharge tube in which the pressure is to be controlled and simultaneously measures the pressure, controls it, and cleans the gas continuously. The system consists of a self-maintained high-voltage low-pressure discharge cell in which positive gas ions are generated in a crossed-field trapped plasma, and the ions are accelerated into the cathode surfaces which partly at least consist of the gas reservoir material. This ion bombardment enhances the gas absorption rate into the gas reservoir material of the closed vessel. (W.H.K.)

Radiation Effects on Instruments and Instrument Components

49172 ELECTRICAL PHENOMENA ON IRRADIATING A COAXIAL CABLE WITH A NEUTRON AND GAMMA FLUX. Zaidel, R. M. Zh. Prikl. Mekh. Tekh. Fiz., No. 3, 66-76(May-June 1968). (In Russian).

An electric field occurs in a dielectric on irradiation by neutrons and gamma rays principally because of polarization of the medium. It is assumed that a dielectric with a dielectric constant ϵ fills the space between two concentric conducting surfaces having radii r_1 and r_2. The cable is irradiated from one side by gamma rays. The average range of Compton electrons is δ. A positive ion remains at the site where an electron is knocked out by interaction with a gamma ray. On irradiating with neutrons, a recoil proton is knocked out. It is found that the volume charge density over the whole dielectric is constant and equal to: $\rho_0 = \text{const} = -C$, $C = e_0 \delta J/(N \lambda_0^2)$. Here e_0 is the absolute value of the electron charge; δ is the range of Compton electron; J is the number of gamma quanta per cm^2; N is the number of absorbed gamma quanta to produce one Compton electron, and λ_0 is the range of the gamma quanta in the dielectric. Equations are then developed for the total charge q_0 per 1 cm of cable length, and a formula is derived for the difference in potential between the inner and outer surfaces. The buildup of charge as a function of time is taken into account. (TTT)

49173 EFFECTS OF NEUTRON BOMBARDMENT ON SILICON DIODES. Korshunov, V. D.; Kostyuchenko, E. A. (Ulyanov Polytechnic Inst., USSR). Izv. Vyssh. Ucheb. Zaved., Fiz., No. 6, 15-19(1968). (In Russian).

Studies of silicon mesa diodes irradiated by a 1-MeV neutron flux of 8.5×10^{14} neutrons/sec showed that fast neutron bombardment reduces the current output proportionally to the neutron flux. The reduction in current output is explained by the increased specific resistance in the semiconductor material. The current output changes are stable in character. The magnitude of feedback current is increased by fast neutron bombardment. Moreover, the increased current does not exceed 50% of the initial magnitude at a neutron flux of 8×10^{14} neutr/cm^2. It was also established that p-silicon with $\rho = 5$ ohm cm retains its efficiency at neutron fluxes not exceeding (1 to 2) $\times 10^{14}$ neutr/cm^2. (R.V.J.)

LIFE SCIENCES

Biochemistry, Physiology, and Molecular Biology

Refer also to abstracts 49282, 49331, 49332, 49409, 49447, 49463, 49486, 49487, 49495, 49537, 49546, 49563, 49565, 49570, 49606, 49607, 49609, 49612, 49637, 49644, 49651, 49653, 49654, 49674, and 49676.

49174 (AERE-M-2005) THE RESULTS OF A YEAR'S EXPERIENCE OF A NEW PROGRAMME FOR ^{239}Pu URINE SAMPLING AND ANALYSIS. Eakins, J. D.; Knight, S. (Atomic Energy Research Establishment, Harwell (England)). June 1968. 8p. Dep. CFSTI. UK 1s. 9d.

A new program of urine sampling and analysis for ^{239}Pu was introduced at AERE. This memorandum summarizes the results for the first full year of operation and compares them with the results obtained previously. Since the new program was introduced the number of samples exceeding 0.2 pCi/24 hours has decreased from 6 per cent to <1 per cent. This is considered to be due to the collection of samples at home instead of at work in the vicinity of active areas. The advantages and disadvantages of the sampling program are discussed with reference to overnight sampling, the use of creatinine in urine as an index of urinary excretion rate, and the value of consecutive urine samples. The mean correction factor required to convert overnight samples to 24 hour voidings, based on creatinine content, was found to be 2.03, and the average volume of urine excreted per day on the same basis is 1560 ml. (auth)

49175 (CONF-680410--, pp 16,1-23) RADIATION EXPOSURE RATES: EFFECTS ON THE IMMUNE SYSTEM. Gengozian, N.; Carlson, D. E.; Gottlieb, C. F. (Oak Ridge Associated Universities, Tenn.).

The effects of whole-body irradiation on the immune system of a variety of animal species is well documented, and a primary distinction has been made between an acute (minutes, hours) and chronic (days, weeks) radiation exposure. The general acceptance of these temporal classifications, as demonstrating differential biologic effects, although valid, has resulted in a limited consideration of a more narrow range of exposure rates, e.g., minutes versus hours, particularly as related to their effect on an immune system. Results showed that a radiation exposure rate of 53 R/min is far more effective in assuring survival of a foreign marrow graft in irradiated mice (total dose 900 R or 1200 R) than an exposure rate of 4 R/min, 19 R/min, and 39 R/min. The take or nontake of the foreign graft (xenogenic or allogeneic) was found to be a reflection of the degree of suppression and rate of recovery of the immune response, i.e., the greater the exposure rate, the greater the immune suppression. The existence of an exposure-rate-dependent immune mechanism was documented further in mice that had received varying doses of whole-body irradiation at exposure rates ranging from 8 R/min to 70 R/min and subsequently challenged with sheep red-cell antigen. Humoral antibody formation to this antigen was greater in those mice receiving radiation at the lower exposure rates in the sublethal range of 400 R-800 R. With total doses greater than 800 R, the exposure-rate effect was not apparent owing to the almost complete suppression of humoral antibody formation. This is in contrast to the effects noted in the marrow transplantation system, where graft rejection could be demonstrated after 1200 R given at the low exposure rate of 4 R/min. An examination of the quality of radiation with which the exposure-rate effect could be demonstrated showed ^{60}Co gamma rays > 250 keV X ray > fast neutrons. Indeed, with neutrons (fast neutrons from the Oak Ridge National Laboratory Health Physics Research Reactor) no exposure-rate effect was apparent, either in animal mortality or immune response. (auth)

49176 (JPRS-43645, pp 95-7) RECOMBINATION OF UNPAIRED ELECTRONS IN IRRADIATED PROTEINS AND POLYPEPTIDES. L'vov, K. M. Translated from Biofizika, 12: 347-9(1967).

Synthetic polypeptides and proteins were treated with uv and γ radiation. Graphs are presented to show roasting curves of poly-γ-methyl-l-glutamate, poly-γ-benzyl-l-glutamate, hemoglobin, trypsin, egg white, serum albumin, pepsin, protamine, procollagen, and silk fibroin. Results show that recombination of the unpaired electrons begins at a very low temperature and finishes at a temperature of +60 to +200°C. The curves characterize the depth of the unpaired electron traps in the specimen. The distribution of traps by depth is determined by the first derivative of the roasting curve, and a certain set of traps is characteristic of each protein and polypeptide. It was shown that the temperature range in which recombination of the unpaired electrons takes place during roasting of the dry irradiated proteins and polypeptides depends on their secondary structure. (H.L.W.)

49177 (NP-16519) SODERZHANIE STRONTSIYA-90 V KOSTNOI TKANI NASELENIYA SSSR (MATERIALY 1964 G). (Content of ^{90}Sr in Human Bone in the USSR (Data for 1964)). Marei, A. N.; Knizhnikov, V. A.; Yartsev, E. I. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnio Energii SSSR, Moscow). 1965. 8p. (In Russian). Dep.

Strontium-90 was determined in human bones and in teeth from human cadavers. Samples were collected from various age groups in 32 cities throughout the Soviet Union. Data for bone and teeth ^{90}Sr content are normalized to the skeleton. (H.G.D.)

49178 (ORO-3546-6) INFLUENCE OF THE PHYSICAL STATE OF CHROMATIN ON NUCLEIC ACID AND PROTEIN SYNTHESIS AND ON RADIATION SENSITIVITY OF CELL DIVISION. Progress Report. Gaulden, Mary Esther (Texas Univ., Dallas. Southwestern Medical School). May 27, 1968. Contract AT(40-1)-3546. 7p. Dep. CFSTI.

Embryos of the grasshopper, Chortophaga sp., were kept at 8°C and removed at monthly intervals up to six months. It was found that hatchability was about 90 to 95% in contrast to 78% for controls kept at room temperature. The effects of chromatin condensation on RNA synthesis were measured by uptake of tritium-labeled uridine. No uptake occurred during prometaphase, metaphase, or anaphase. Results of other studies indicated that the uptake of DNA and RNA precursors could be controlled to varying extents, depending on mitotic stage, by experimental alteration of the degree of chromosome condensation with hypertonic medium. An ultraviolet microbeam apparatus is being used to determine the relation of a radioinduced change in chromatin state to the uptake of tritium-labeled thymidine that occurs in irradiated prophase cells. Studies on prevention of radioinduced mitotic inhibition by post-treatment with hypertonic medium are being completed. (H.L.W.)

49179 (ORO-3578-4) [EFFECTS OF RADIATION ON PERMEABILITY AND ENZYMES OF SKIN]. Progress Report. [Olson, Robert L.; Everett, Mark Allen; Nordquist, John] (Oklahoma Univ., Oklahoma City. Medical Center). July 22, 1968. Contract AT(40-1)-3578. 5p. Dep. CFSTI.

Permeability of normal and injured skin was investigated by electron microscopy and cellular histochemistry. The relationship of lysosomes to cellular ingestion and the distribution of acid phosphatase, ferritin, and aryl sulfatase within lysosomes were studied. The role of pinocyte vesicles in skin permeability is discussed. Following uv irradiation, a decrease in electron density of epidermal cells and an increase of melanin were observed. Sunlight as an etiologic factor in skin cancer is discussed. A considerable degree of phagocytic ability was observed in epidermal cells. It was found that latex particles were taken into the nucleus of epidermal cells in substantial quantities. (H.L.W.)

49180 (PRNC-14) RESONANCE IN RADIATION EFFECTS. Progress Summary Report No. 1. Gomberg, Henry J.; Luse, Robert A.; Vazquez Martinez, Florencio (Puerto Rico Nuclear Center, [Mayaguez]). Mar. 1963. Contract AT(40-1)-1833. 11p. Dep. CFSTI.

Dilute solutions of the iron metalloenzyme catalase were irradiated with a beam of monochromatic x rays having photon energies in the 6 to 9 KeV region and with a high purity. Irradiation was carried out in a sample holder constructed of methacrylate plastic with a thin Mylar film window. A ferrous-ferric micro-dosimetry technique was developed. Results of dosimetry are presented in the form of a graph showing monochromatic x-ray beam intensity as a function of photon energy. Another graph shows results of radiation experiments using monochromatic x rays in the energy range 6.4 to 8.3 keV. This graph shows inactivation of catalase at or near the K absorption edge of iron; this is evidence of resonance. Other studies on resonance included characterization of a high intensity monochromatic x-irradiation system in the 5 to 20 keV region. Graphs are presented showing intensity and energy distributions and percentage of the second harmonic contamination. (H.L.W.)

49181 (SWRHL-36r) STATUS OF THE NEVADA TEST SITE EXPERIMENTAL FARM. Summary Report, July 1964-December 1965. Douglas, Richard L. (Public Health Ser-

vice, Las Vegas, Nev. Southwestern Radiological Health Lab.). Jan. 17, 1967. 33p. Dep. CFSTI.

An experimental farm facility was required to determine the passage of ^{131}I through air-forage-dairy cow-milk-man food chain. The following aspects of the experimental farm facility are described: specific site characteristics, cultivated area, well and reservoir, irrigation system, other agricultural equipment, laboratory and animal facilities, and permanent research and support equipment. Agronomy practices are discussed with regard to irrigation, crops, and fertilization. Crops planted were Ramona wheat, Alpine barley, Sudan grass, Kanota oats, Lahontan alfalfa, and rye. One experiment, Project Hayseed, was performed. An aerosol tagged with ^{131}I was released over Sudan grass. The grass was cut and fed to groups of lactating cows. An additional group of cows was placed in the aerosol cloud for an inhalation study. The levels of ^{131}I in the milk were related to ^{131}I concentrations in forage and air. Tables are appended showing precipitation data, irrigation data, and fertilizer applications. (H.L.W.)

49182 (TID-24637) ^{234}Th DISEQUILIBRIUM IN THE OCEAN. Bhat, Suman; Krishnaswamy, S.; Rama (Tata Inst. of Fundamental Research, Bombay (India)); Moore, Willard S. (State Univ. of New York, Stony Brook. Dept. of Earth and Space Sciences). [1968]. 10p. Dep. CFSTI.

The spatial distribution of ^{234}Th is studied in the top 200 meter levels of coastal and open ocean waters. The value of the $^{234}Th/^{238}U$ activity ratio ranged from 0.2 to 1.4. This marked disequilibrium between ^{234}Th and its immediate parent demonstrates the possibility of using ^{234}Th as a tracer for studying rapid near-surface reactions associated with chemically active species in sea water. Any disequilibrium observed on the time scale of the 24 day half-life of ^{234}Th must be attributed to the gravitational settling of dust, biological materials, and inorganic precipitates present in sea water. Thus studies of ^{234}Th in surface waters are linked to the current rate of accumulation of sediments at the ocean floor. (auth)

49183 (UCB-34-P-95-15) RADIATION OF HEME PROTEINS. Progress Report, October 1, 1967–September 30, 1968. Brown, W. D. (California Univ., Berkeley. Inst. of Marine Resources). June 15, 1968. Contract AT(11-1)-34. 8p. Dep. CFSTI.

Myoglobins from tuna and sperm whale were irradiated in solutions of varying pH. Peptides were separated from the parent myoglobin molecule by chromatography. It was found that irradiated myoglobins undergo autoxidation at rates from 20 to 50% higher than controls. The enhanced oxidation was interpreted to be the result of an opening of the molecule around the heme group and partial removal of the protective hydrophobic pocket. The oxidation was inversely proportional to pH for irradiated as well as for control myoglobins. The addition of flavin compounds, DPNH, and EDTA to purified metmyoglobin resulted in reduction to oxymyoglobin. The reduction was much more rapid at pH 6.4 than at 7.4. It was observed that reduction of myoglobins from mammals occurred at much faster rates than those from tuna. The rate of oxidation of both control and irradiated myoglobins was greatly increased by the addition of flavin mononucleotide. Reduction of control and irradiated myoglobin by flavin mononucleotide is being studied. Preparations of mammalian muscle are being investigated for the occurrence of multiple myoglobins. (H.L.W.)

49184 (UCRL-50461) STUDIES ON LIVER DNA IN TRITIATED KANGAROO RATS LIVING AT SEDAN CRATER. Hatch, F. T.; Mazrimas, J. A.; Greenway, G. G.; Koranda, J. J.; Moore, J. L. (California Univ., Livermore. Lawrence Radiation Lab.). July 10, 1968. 28p. Dep. CFSTI.

Kangaroo rats (Dipodomys merriami) living near the crater of an old nuclear detonation were found to be uniformly tritiated. The lifetime chronic dose to adult animals was estimated to be 10 rad from internal ^{3}H and 10 rad from persistent external β- and γ-emitting radionuclides. Liver DNA was isolated from these animals and from control animals trapped in areas not enriched in radionuclides. DNA from the crater animals contained 6×10^{6} dpm/g hydrogen. In comparison with control DNA, the crater DNA exhibited the following: more protein and histone, higher molar absorbance at 260 mμ, lower thermal transition magnitude with a small secondary transition, lower mole fraction of A + T nucleotides, increased template activity for 2 RNA polymerases and 1 DNA polymerase, and relative increase in ATP-γ-^{32}P incorporation. There was no difference in the molar absorbance after heat denaturation, thermal transition midpoint, intrinsic viscosity before or after heating, or susceptibility to hydrolysis by DNAase I. The physicochemical observations are compatible with a slight degree of unfolding or disorganization in the structure of the DNA of the crater animals. The enhanced template activity may have resulted from the introduction of additional binding sites for the polymerases by the radiation exposure or by subsequent repair mechanisms. Thus a radiation effect at a very low chronic radiation exposure has been demonstrated with biochemical techniques. We cannot conclude that the changes were harmful, because the population in which they were observed was apparently a healthy one. However, we must conclude that the changes are potentially harmful because they involve DNA, which plays a central role in normal and abnormal cell behavior. The exposure to radiation in this study approached levels which could be encountered in peaceful applications of nuclear energy. (auth)

49185 (YALE-2653-33) EFFECTS OF RADIATION ON BIOLOGICAL MOLECULES. Progress Report, July 1, 1967–July 1, 1968. Hutchinson, Franklin (Yale Univ., New Haven, Conn. Dept. of Molecular Biophysics). Aug. 1, 1968. Contract AT(30-1)-2653. 32p. Dep. CFSTI.

The mechanism of sensitization by the incorporation of 5-bromouracil of bacterial transforming DNA to uv light was studied. Ultraviolet-induced breaks in hybrid DNA were predominantly in the strand containing bromouracil. It was also shown that the loss of transforming activity by uv irradiation of Bacillus subtilis DNA with all thymine replaced by bromouracil is quantitatively accounted for by the single strand breaks, with negligible contribution from other damage to the bases. When thymine is fully replaced by bromouracil, the shape of the survival curve against uv radiation changes from the usual concave curve to exponential. The loss of transforming activity of hybrid DNA is greater than that which would be calculated under the assumption that the individual strands lose activity in the same way as the normal unsubstituted DNA and the fully substituted DNA. It was shown that the magnesium ion was required for the uptake of DNA in bacterial transformation. In order to determine whether the EDTA sensitive step was involved in the uptake process, one of two portions of a preparation of competent cells was pretreated with EDTA. The appearance of DNAase-resistant transformants was then followed after addition of DNA to both cultures. After six minutes, excess Mg^{++} was added to the EDTA culture. The results show that uptake was essentially prevented by EDTA for at least six minutes. The subsequent addition of excess Mg^{++} completely removed the inhibition, allowing normal uptake kinetics to follow. Figures are presented to show the effects of EDTA and magnesium on DNA uptake, binding of DNA in EDTA, uptake of DNA in EDTA, marker uptake in the presence of EDTA, and bound vs. unbound marker uptake in EDTA. An isolation procedure for extracting large DNA molecules from stationary phase cells of Bacillus subtilis is described. The sedimentation rate of the isolated DNA was followed using T_2 DNA as a marker. (H.L.W.)

49186 SUBMICROSCOPIC REACTION OF SECRETORY NEURONS UNDER THE CONDITIONS OF WHOLE-BODY GAMMA RADIATION. Voitkevich, A. A.; Dedov, I. I. (Inst. of Medical Radiology, Obninsk, USSR). Folia Morphol., 15: 88-97(1967).

The results of optical and electron microscope studies of the neurons of the supraoptic nucleus of the rat hypothalamus after whole-body γ irradiation with 900 R are reported. The astrocytes and oligodendroglia react first. The cytoplasm of glia satellites became vacuolized and the mitochondria enlarged after 24 hr. Stimulation of the synthesis of specific substances in the neurosecretory cells accompanied the increase in the absorptive capacity of the capillary endothelium 48 hr after irradiation. During the culminative phase of radiation sickness the functional changes were accompanied by cell destruction. Fragmentation of the processes of the satellites was synchronized with the progress of karyopyknosis and karyolysis in the secretory neurons. The zones of ruptures in the cytoplasmic matrix were mainly localized to areas of maximum lysosome aggregation. Lysis and fragmentation of the cristae of the swollen mitochondria gave rise to large vacuoles. Reduction of ribonucleoprotein particles of the ergastoplasm led to the inhibition of the synthesis and formation of the elementary granules of the neurosecretory material. The outer membrane of the neuron showed maximum resistance to radiation compared with the different membranous structures. The part played by separate cellular organelles in the manifestation of the effect of irradiation on a cytological level is discussed. (61 references) (BBB)

49187 EFFECT OF IONIZING RADIATION ON THE RESPIRATORY METABOLISM OF SPROUTING SEEDS. Amberger, A.; Suess, A. (Bayerische Landesanstalt fuer Bodenkultur, Pflanzenbau, und Pflanzenschutz, Munich. Technische Hochschule, Munich). Atompraxis, 14: 296-9(July 1968). (In German).

A single irradiation of grains of barley with small doses (1 to 100 R) of ionizing radiation caused a certain acceleration in sprouting and in the initial development of the sprouts. In the glutathione/ascorbic acid-ascorbic acid oxidase system, the SH

groups and the enzyme ascorbic-acid oxidase proved to be particularly sensitive to radiation. The amount of dehydroascorbic acid decreased more under the influence of radiation than did that of ascorbic acid. In the course of the experiment (10 days), the individual substances regenerated in varying manner. (auth)

49188 INFLUENCE OF X-IRRADIATION ON SPROUTS AND METABOLISM OF POTATO TUBERS DURING STORAGE. Scheid, W.; Heilinger, F. (Forschungsanstalt fuer Landwirtschaft, Brunswick). Atompraxis, 14: 299-302(July 1968). (In German).

Potatoes of the Maritta variety were stored during the winter at between 12°C and 4°C, and then were irradiated in sproutless condition with relatively low x-ray doses (400 to 3200 R) at two different times (in February unsprouted, and in July weakly or strongly sprouted). After irradiation, they were stored in the dark at 20°C. The test was to determine whether and to what extent the influence of the radiation depends upon the metabolism of the plant (sprouted or unsprouted condition) immediately before irradiation. The results show that sprouting, CO_2 respiration, and sugar metabolism are influenced in varying manner. Thus, in evaluating the inhibitory effect of ionizing radiation on sprouting, the metabolism of the tuber must be considered. In addition, a study was made to determine whether it is possible to inhibit sprouting in potatoes after storage at low temperature during the winter (12 to 4°C) by irradiating them with relatively low doses in the spring (400 to 3200 R) after restorage under unfavorable conditions (20°C). Under the conditions we chose, sprouting can be inhibited only for 10 days by irradiation with 3200 R. The inhibitory effect is probably greater if the potatoes are stored at temperatures below 20°C, or if the radiation dose is greater. In determining the inhibitory effect of ionizing radiations of varying intensity, it was found that irradiation with a dose output of 45 R/min is more effective than one with 4 R/min. (auth)

49189 CHEMOCYTOLOGY OF LETHALLY IRRADIATED AMOEBA. Chatterjee, Samar (Presidency Coll., Calcutta). Sci. Cult. (Calcutta), 34: 108-10(Mar. 1968).

Soil amoebae, Acanthamoeba sp., were x-irradiated with the following doses: 150, 165, 185, and 200 Kr. After irradiation they were transferred to slides, fixed, and stained 24, 48, 72, and 96 hrs following exposure. The DNA stainability, as revealed by the Feulgen technique and methyl green, remained unimpaired. At doses of 150 and 165 Kr the cytoplasm and the nucleus showed normal to moderate stainability in toluidine blue and pyronine. At higher doses, dense patches of localized RNA-positive material were observed in the cytoplasm. Nuclei exhibited a pycnotic condition and were heavily stained with toluidine blue. At all doses, a moderate to negative stainability was found to occur with the PAS technique. The localization of alkaline phosphatase in lethally irradiated amoebae remained unaltered. (H.L.W.)

49190 NEW CONTRIBUTION CONCERNING THE USE OF RADIOISOTOPES IN PLANT PHYSIOLOGY. van den Hende, A. (Faculte des Sciences Agronomiques, Grand, Belg.). Atompraxis, 14: 294-6(July 1968). (In German).

A method for the quantitative determination of salts or labeled complexes absorbed by the leaf after foliar application is described. The experiments with this quantitative method were conducted to control the absorption of ions, i.e., phosphate, in function of the quantity of this nutrient present in the soil; similar experiments were performed to study the foliar absorption of ^{22}Na salts after application of different Na and K quantities to soils varying in texture. Finally an experiment was made on the absorption of Mn (salts and complexes). It was stated that numerous factors influence the foliar absorption which may be considered as a supplement to the ordinary root-absorption. More extended fundamental research has to be undertaken to test the practical possibilities which the author regards as being very important. (auth)

49191 CHANGES IN THE ULTRASTRUCTURE OF EHRLICH CARCINOMA CELLS UNDER THE INFLUENCE OF ROENTGEN RAYS. Woyke, Stanislaw; Olszewski, Wlodzimierz; Domagala, Wenancjusz (Pomeranian Medical Academy, Poland). Acta Med. Pol., 8: 407-13(1967).

The changes in ultrastructure of Ehrlich carcinoma cells elicited by x irradiation were compared with changes induced by treatment with cytostatic drugs. Mice were irradiated daily for 8 days with 400 R to the abdomen starting 7 days after intraperitoneal injection of ascites tumor cells, with a 1-day interval on the sixth day. On the fifth, seventh, and eighth day of the experiment, ascitic fluid, representing a suspension of tumor cells, was obtained by puncture. The changes observed included separation of the external lamina of the nuclear membrane on the fifth day after irradiation, increase in the number of mitochondria and elements of the endoplasmic reticulum on the seventh day, and swelling of mitochondria on the eighth day of the experiment. They were not observed in all the cells of the population, but they were typical in most cells of the preparation. Cells exhibiting no changes were also observed. (BBB)

49192 INVESTIGATIONS ABOUT UPTAKE AND TRANSLOCATION OF ^{45}Ca-CHLORIDE AFTER SPOT APPLICATION ON APPLE SKINS IN DIFFERENT STATES OF FRUIT DEVELOPMENT. Wieneke, J. (Univ., Bonn. Arbeitsgruppe Institut fuer Landwirtschaft der Kernforschungsanlage, Juelich, Ger.). Atompraxis, 14: 305-8(July 1968). (In German).

Autoradiographic and analytical investigations were carried out to trace the translocation of ^{45}Ca-chloride after spot application on the skin of apple fruit of the variety Cox Orange Renette during two periods of vegetation. The translocation of calcium was most effective in the early stage of young apples and decreased quantitatively and qualitatively with further developing of the fruit. After application of calcium mixed with pesticides used in praxis calcium, transport through the skin into the fruit was not substantially influenced. (auth)

49193 CROSSLINKAGE THEORY OF AGING. Bjorksten, Johan (Bjorksten Research Foundation, Madison, Wis.). J. Amer. Geriat. Soc., 16: 408-27(Apr. 1968).

Crosslinking of molecules was damaging to tissues and resulted in loss of elasticity, reduced swelling capacity, increased resistance to hydrolases and probably enzymes generally, and thus an increase in molecular weight and a tendency toward embrittlement. There was increasing evidence supporting the relation between crosslinking and aging. Crosslinking agents present in the living organism included aldehydes, lipid oxidation products, sulfur, alkylating agents, equinones, free radicals induced by ionizing radiation, antibodies, polybasic acids, polyhalo derivatives, and polyvalent metals. The role of free radicals induced by ionizing radiation was discussed. It was suggested that some of the crosslinkages in the body might be due to cosmic radiation, radiopotassium as an internal emitter, and incidental contact with fallout, x-ray diagnostic exposures, and luminescent dials in watches or other instruments. However, all sources considered together would not account for more than 5 to 10% of aging. Attempts to use free radical-neutralizing chemicals to prolong the life of test animals did not lead to positive results. It was concluded that the crosslinkage theory of aging explained the life-shortening effect of ionizing radiation and the aging effect of uv irradiation on the skin. (BBB)

49194 SOME SEASONAL AND PHYSIOLOGICAL EFFECTS ON ^{137}Cs AND $^{89,90}Sr$ CONTENT OF THE WHITE-TAILED DEER ODOCOILEUS VIRGINIANUS. Rabon, E. W. (E. I. du Pont de Nemours and Co., Aiken, S. C.). Contract AT(07-2)-1. Health Phys., 15: 37-42(July 1968). (DP-MS-67-33).

Strontium-89 and ^{90}Sr in bone and ^{137}Cs in muscle tissue were detected in 369 white-tailed deer, collected during 1965 and 1966 on the Savannah River Plant site. The radiostrontium content of the bones varied with the age of the deer. Bone ash of fawn (0 to 11 months) contained an average of 99 pCi $^{89,90}Sr$/g Ca, but bone ash of deer over 3 yr old averaged only 50 pCi $^{89,90}Sr$/g Ca. Size, sex, and season had no apparent effect on uptake of $^{89,90}Sr$ in bone. Deer collected in the fall and winter months had significantly higher concentrations of ^{137}Cs in flesh and rumen (6.1 and 8.9 pCi/g, respectively) than did deer collected in the spring and summer (2.2 and 3.3 pCi/g, respectively), although maximum deposition of fallout ^{137}Cs occurs in the spring. At the 95% confidence level, small (95 to 115 cm) deer had higher ^{137}Cs concentrations then larger deer. (UK)

49195 ^{90}Sr TISSUE DOSES IN THE CALF SKELETON AS A FUNCTION OF THE CALCIUM CONTENT IN THE RATION. Sarapu'l'tsev, I. A.; Panchenko, I. Ya.; Sirotkin, A. N. (Inst. of Biophysics, Moscow). Radiobiologiya, 7: 860-5(1967). (In Russian).

Clinically healthy calves with an average live weight at birth of 37 ± 4 kg received rations containing 6 to 8 (the normal) and 23 to 35 g of calcium. Strontium-90 was administered perorally from the first day of life at the rate of 110,000 μcuries/g of calcium. The animals were slaughtered after 30, 90, and 180 days and the ^{90}Sr and calcium were determined in various bones. The protective role of calcium against ^{90}Sr increased with the age of the animals. The distribution of ^{90}Sr in the bone did not depend on the calcium level in the ration. (JPRS)

49196 THE EFFECTS OF ULTRAVIOLET LIGHT AND X-IRRADIATION ON MAMMALIAN PIGMENT CELLS IN VITRO. Silver, Stephen E.; Hu, Funan (Univ. of Oregon Medical School, Portland. Oregon Regional Primate Research Center, Beaverton). J. Invest. Dermatol., 51: 25-32(July 1968).

Both x and uv irradiation produced in vivo hyperpigmentation in cells of transplantable mouse melanomas. The effects of irradiation of melanocytes in tissue cultures failed to produce any cell proliferation or increased production of melanin by these cells after such treatment. In addition, these two modalities acted in qualitatively different fashions on melanocytic cells. X irradiation arrested mitotic activity and produced slow cell death and morphologic changes similar to those occurring in aging tissue culture populations. Ultraviolet light irradiation resulted in cell destruction during the first 5 days after irradiation, but the cells that survived seemed to be completely normal. (auth)

49197 ANTIBODIES TO DEOXYRIBONUCLEIC ACID IRRADIATED WITH ULTRAVIOLET LIGHT: DETECTION BY PRECIPITINS AND IMMUNOFLUORESCENCE. Tan, Eng M. (Scripps Clinic and Research Foundation, La Jolla, Calif.). Science, 161: 1353-4(Sept. 27, 1968).

Two rabbits were immunized with a complex consisting of ultraviolet-irradiated DNA and methylated bovine serum albumin. Serum antibodies reacted only with irradiated DNA, and the serological reaction was shown by immune-precipitation and immunofluorescence. (auth)

49198 INVESTIGATION OF THE CHARACTER OF RADIATION DAMAGE OF SUPERMOLECULAR DNA BY HYDRODYNAMIC SHEARING. Struchkov, V. A.; Strazhevskaya, N. B. (Inst. of Biological Physics, Moscow). Radiobiologiya, 7: 819-24(1967). (In Russian).

Solutions of supermolecular DNA from rat thymus and molecular DNA from bacteriophage T-2 were irradiated at 700 R/min to give doses of 0.05 to 15 kR and subjected to mechanical degradation by passing them through the capillaries of a viscoelastometer at different pressures. The effect was similar in both types of DNA, whose resistance to hydrodynamic forces was reduced 90% by irradiation. This indicated that damage to the molecular structure of supermolecular DNA was the basis of the change in its viscoelastic properties. (JPRS)

49199 LUMINESCENCE OF NUCLEOSIDES, NUCLEOTIDES, AND DNA AT 77°K. Imakubo, Keiichi (Kyoto Univ.). J. Phys. Soc. Jap., 24: 143-51(Jan. 1968).

In order to obtain detailed information on the uv-induced energy transfer and the excited states in DNA, the fluorescence and phosphorescence of nucleosides, nucleotides, and DNA in 1:1 by volume of ethylene glycol-water at 77°K were studied. Our main conclusions were: at neutral pH, both the purine derivatives and the pyrimidine derivatives phosphoresce, with the lifetimes of 1.25 to 2.45 sec and 0.45 to 0.65 sec, respectively, the lowest triplet state energy of the five bases decreases in the following order: cytosine, guanine, adenine, uracil, thymine, the phosphorescence of DNA is composed of the two components that originate from the neutral thymine and the neutral adenine, but the lowest triplet state of DNA is almost located on the neutral thymine bases (more than 95%), the fluorescence of DNA, which is red-shifted by about 35 mμ from an equimolar mixture of its constituent nucleotides, is understood in terms of the interaction of bases stacked on the same strand in the first excited singlet state, are the energy transfer in DNA takes place not via the hydrogen bond between strands but along the strand. (auth)

49200 STUDIES ON SYNTHETIC HYDROXYAPATITE CRYSTALS WITH REGARD TO METABOLISM OF CALCIUM, STRONTIUM, BARIUM, AND RADIUM IN BONE. I. THE DISCRIMINATION AGAINST CALCIUM. Stark, G. (Univ. des Saarlandes, Homberg, Ger.). Biophysik, 5: 42-54(1968). (In German).

The system hydroxyapatite crystals in a proper solution, in a way, represents an in vitro analogue to metabolism of alkaline earths in bone. Experiments are described to find differences in the behavior of Ca, Sr, Ba and Ra to synthetic hydroxyapatite crystals. Synthesizing of the crystals is discussed and the discrimination ratios of Ca to Sr, Ba and Ra were measured. Furthermore the exchange of alkaline earths between preformed crystals and a proper solution was studied over a period of 1000 hr. The discrimination ratios grew larger with increasing ionic radius in the order Sr, Ba, Ra. While Sr could replace Ca ions also in the interior of the crystals, Ba and Ra were limited to crystal surface. With respect to the discrimination of bone it must be concluded that further processes participate. (auth)

49201 A PROCEDURE FOR DETERMINATION OF RADIOACTIVE METABOLITES FROM TRITIUM-LABELED OXYTOCIN IN TISSUES. Sjoholm, Ingvar; Ryrfeldt, Ake (Royal Pharmaceutical Inst., Stockholm). Acta Pharm. Suec., 4: 77-80(Apr. 1967).

A procedure is described for the determination of tritium in tissues after homogenization, precipitation of proteins with trichloro-acetic acid, thin-layer chromatography of the soluble fraction, and direct liquid-scintillation counting of the radioactivity of the thin layer. Highly tritium-labeled oxytocin and lysine-vasopressin were synthetized starting from L-3-^{3}H-tyrosine and the proper heptapeptide derivatives. The high specific radioactivity of the peptides obtained enabled tracer studies to be made in vivo after injection of small doses of the hormones, and tritium content of the blood and tissues could be conveniently determined with reasonable efficiency and accuracy. Organs to be studied were removed as quickly as possible, and cooled in dry ice and ethanol to stop enzymic activity immediately. Then 2N acetic acid (about 1 ml/0.3 g tissue) was added to prevent degradation of oxytocin during the thawing together with a carrier solution (200 to 500 μl with nonradioactive oxytocin, oxytocin-nonapeptide, and tyrosine). To the homogenate, 20% trichloroacetic acid (TCA) in water was added dropwise to a total concentration of 5% TCA, to precipitate the proteins. The centrifugate was extracted five times with ether to remove TCA, and the solution was dried in vacuo. The dried residue was dissolved in 0.1M acetic acid and subjected to thin-layer chromatography and tritium determination. Chromatographic separation of the tritium metabolites was performed on a mixed layer of cellulose powder MN 300 and silica gel G. Chromatography was performed in n-butanol-dioxane-2N ammonia (4:1:5). It was shown that oxytocin was rapidly degraded in vivo. Just as in the liver, very small amounts (less than 1% of the total radioactivity) of intact oxytocin could be detected in the kidneys 2-½ min after intravenous injection of tritiated oxytocin, and the main part of the radioactivity migrated as tyrosine. This also applied to other tissues in the rat. (BBB)

49202 SOME PULSE RADIOLYTIC OBSERVATIONS ON THE REACTIVITY OF HYDROXYL RADICALS WITH DNA AND POLY A. Loman, H.; Ebert, M. (Christie Hospital and Holt Radium Inst., Manchester, Eng.). Int. J. Radiat. Biol., 13: 549-57(1968).

The apparent reactivity of DNA to OH radicals, as measured by the thiocyanate competition method, proved to be dependent on the absolute concentrations at a constant concentration ratio of CNS^{-} to DNA. This phenomenon could be explained qualitatively as being the consequence of the inhomogeneous distribution of the nucleotides in DNA solutions. Single stranded DNA and polyadenylic acid showed an increased reactivity to OH radicals when compared with the double-stranded forms of the same polymers. (auth)

49203 ON THE UNIFIED METHODICAL APPROACH IN THE STUDY OF THE ABSORPTION OF RADIOACTIVE SUBSTANCES THROUGH THE NONINJURED SKIN OF ANIMALS. Tarasenko, N. Yu.; Burykina, L. N.; Khodyreva, M. A. Med. Radiol., 13: No. 8, 48-53(Aug. 1968). (In Russian).

The possibility of sorption through the skin of soluble compounds of different radioactive isotopes was studied. At the same time experiments of different authors in this aspect were sometimes conducted without adequate quantitative assessment, on diverse animals with varying degrees of pollution and sizes of the application field. On the basis of literature data and personal observations, a unified methodical approach is proposed for experiments involving studies of the resorption of radioactive substances through the skin. The obtaining of comparable quantitative data on sorption of radioactive substances through the skin is possible only in definite conditions of the experiment, such as: the choice of experimental animals, density of radioactive pollution per area of surface, size of the application field in some species of animals, time of the exposition, and biological criteria for determining the absorption coefficient. (auth)

49204 ASSESSMENT OF THE PHYSICO-CHEMICAL STATE OF ISOTOPES IN THE TISSUES OF THE ORGANISM. Lyubashevskii, N. M.; Puchkova, S. M. Med. Radiol., 13: No. 8, 69-70(Aug. 1968). (In Russian).

The physicochemical state of radioisotopes in bone tissue was studied using crushed bone containing equal amounts of ^{45}Ca, ^{90}Sr, and ^{90}Y and treated with 5% nitric acid. It was found that repeated treatments with nitric acid completely removed any traces of ^{45}Ca, ^{90}Sr, and ^{90}Y. Satisfactory results were also obtained with the extraction of polysaccharides from non-decalcinated bone by hyaluronidase. It was shown that the largest amount of osteotropic radioisotopes was fixed by mucopolysaccharides and later redistributed in bone fractions. (R.V.J.)

49205 MARKING POSTLARVAL PARALICHTHID FLOUNDERS WITH RADIOACTIVE ELEMENTS. Hoss, Donald E. (Bureau of Commercial Fisheries, Beaufort, N. C.). Trans. Amer. Fisher. Soc., 96: 151-7(Apr. 1967).

Marking postlarval flounder (Paralichthys spp.) with radioisotopes was studied in two ways: by marking with radiocerium and radiocobalt, and by increasing the concentration of stable Co in the fish and then making it radioactive through exposure to neu-

trons in a nuclear reactor (activation analysis). In the first approach, both ^{144}Ce and ^{60}Co, introduced into the food or water, were used satisfactorily as markers for postlarval flounder. The radioactivity obtained from the water was retained longer than that obtained from food. The amount of Ce accumulated by the fish in 24 hr did not increase when the concentration of ^{144}Ce was raised from 0.4 to 1.0 μCi/ml of sea water, but the amount of ^{60}Co accumulated increased when the concentration was raised from 0.01 to 1.0 μCi/ml of sea water. In the second approach, fish were marked by holding them for 24 hr in sea water with different concentrations of stable Co. Fish held 24 hr in sea water containing 15.62 μg of stable Co per ml of sea water and then held for 36 days in flowing sea water contained enough stable Co to be identified by activation analysis. (BBB)

49206 ACCUMULATION AND DISTRIBUTION OF STRONTIUM WITHIN TISSUES OF A WHEAT SPIKE. Craker, Lyle Eugene. Minneapolis, Univ. of Minnesota, 1967. 85p.
Thesis.

Studies on strontium accumulation in grain of excised wheat spikes from nutrient solution containing strontium indicated genotypic differences in processes governing strontium accumulation in the grain between Red Bobs and Kenya 117A. To determine the nature of the physiological process (i.e., active or passive) governing strontium accumulation in grain, the relationship of physical and metabolic mechanisms to strontium accumulation in grain was studied. Physical processes would be implicated if strontium accumulation in the grain could be correlated with such factors as the vascular anatomy of the wheat spike or differences in transpiration rates of wheat kernels. Metabolic processes would be implicated if strontium accumulation in grain could be related to energy dependent processes. Preliminary studies were conducted to determine the effect of strontium concentration of the ambient solution, plant maturity, hydrogen ion concentration, associated inorganic ions, and absorption time on strontium accumulation in the grain in selecting proper experimental conditions for studies on physiological processes involved in strontium accumulation in the grain. No consistent difference between Red Bobs and Kenya 117A was detected in physical factors of size or number of xylem elements connecting the rachis to the grain. Furthermore, no relationship between transpiration rate and rate of strontium accumulation in grain was observed in either variety. From these results, it was concluded that processes other than passive movement with the transpiration stream were functioning in strontium accumulation in the grain. The association between strontium accumulation in the grain and metabolic processes was indicated by the marked effects of sodium azide and dinitrophenol on strontium accumulation. Strontium accumulation in the grain of excised spikes was significantly inhibited in both varieties 10 and 20 days after anthesis at sodium azide and dinitrophenol concentrations of 1×10^{-3} M. These results led to the conclusion that strontium accumulation in grain was related to processes dependent upon metabolic energy derived from respiration. (Diss. Abstr.)

49207 INCREASE IN ^{45}Ca UPTAKE DURING BARIUM-INDUCED CONTRACTURE IN GUINEA PIG TAENIA COLI. Karaki, Hideaki; Ikeda, Miyoshi; Urakawa, Norimoto (Tokyo Univ.). Jap. J. Pharmacol., 17: 496-7(Sept. 1967).

Changes in ^{45}Ca uptake and total Ca content during smooth muscle tension development in guinea pig taenia coli induced by 0.5 mM Ba were ~ of the same magnitude as that induced by 40 mM KCl. In case of K treatment, both ^{45}Ca uptake and total Ca content of the muscle increased above the control levels. When the muscle was treated with 0.5 mM Ba for 30 min, ^{45}Ca uptake markedly increased but the total Ca content did not change. The Ca content and ^{45}Ca of the muscle treated with 0.5 mM Ba for 15 min showed results similar to the ones treated for 30 min. Increased Ca uptake was observed during the contracture induced by 0.5 mM Ba in the smooth muscle, with a pattern different from the one obtained in high K treatment. These data indicate that Ba increases Ca entry in taenia coli and that this Ca might play an essential role during Ba-induced tension development in the muscle. The change in ^{45}Ca uptake that occurred during Ba-induced contracture is not the result of changes in extracellular space. (BBB)

49208 COMPLEX FORMATION OF NATURAL URANIUM IN THE BLOOD. Chevari, S.; Likhner, D. Med. Radiol., 13: No. 8, 53-7(Aug. 1968). (In Russian).

The distribution of uranium in the blood was studied. Results showed that this distribution is regular. It was found that uranium is bound with erythrocytic membranes. The constants of complex formation of uranyl ion with bicarbonate, plasma albumin, and lipoprotein of erythrocytic membrane were calculated. (auth)

49209 TELLURIUM HYDROCEPHALUS: DISTRIBUTION OF ^{127m}Te BETWEEN MATERNAL, FETAL, AND NEONATAL TISSUES OF THE RAT. Agnew, W. F.; Fauvre, F. M.; Pudenz, P. H. (Huntington Memorial Hospital, Pasadena, Calif.). Exp. Neurol., 21: 120-32(May 1968).

Hydrocephalus was produced in half of the offspring of rats fed 3300 ppM metallic Te in their diet during pregnancy. The distribution of ^{127m}Te as tellurous acid was studied in maternal and fetal tissues after its intravenous injection in pregnant rats fed control and metallic Te diets. The ^{127m}Te freely permeated the placental barrier as well as maternal and fetal blood-brain barriers. In addition to the induction of hydrocephalus in the fetus, the feeding of metallic Te resulted in a significant increase in the uptake of ^{127m}Te by maternal brain but not by nonnervous tissues. Appreciable binding of ^{127m}Te to plasma proteins was observed. The persistence of radioactivity in fetal and maternal tissues for 1 week after injection indicated that prolonged binding of the isotope must also occur in tissues. The possibility of a direct teratogenic action of Te on the fetus was considered. (BBB) (TSS)

49210 PYKNOTIC INTERPHASE DEATH OF CULTURED HUMAN KIDNEY CELLS AFTER HIGH DOSES OF ULTRAVIOLET RADIATION. Scaife, J. F.; Brohee, H. (EURATOM: Ispra, Italy). Int. J. Radiat. Biol., 13: 531-7(1968).

Cultured human kidney cells suffer interphase death within a few hours following uv-irradiation in doses of approximately 30,000 ergs/mm^2, or within 48 hours after doses of 200 ergs/mm^2. Morphologically, this resembles nuclear pyknosis induced in lymphatic cells by low doses of ionizing radiation. The mechanisms of the two forms of cell death are however different, in that respiratory metabolism is not required for the development of uv-induced degeneration. Cells are most sensitive during S and M and least sensitive during the G_1 and G_2-phases of the cycle. (auth)

49211 SURVIVAL OF CULTURED HUMAN CELLS AFTER IRRADIATION WITH FAST NEUTRONS OF DIFFERENT ENERGIES IN HYPOXIC AND OXYGENATED CONDITIONS. Broerse, J. J.; Barendsen, G. W.; van Kersen, G. R. (Nederlandse Organisatie voor Toegepast Natuurwetenschappelijk Onderzoek, Rijswijk, Netherlands). Int. J. Radiat. Biol., 13: 559-72(1968).

Damage to the reproductive capacity of cultured cells of human kidney origin, induced by fast neutrons of different energies, was studied by the cloning technique. Survival curves have been determined for cells in equilibrium with air or nitrogen, irradiated with beams of fast neutrons with modal energies ranging from 1 to 15 MeV. From these experimental data the relative biological effectiveness and oxygen enhancement ratios of the various neutron beams have been derived. The OER-values of fast neutrons were found to vary only little with the modal energy of the beam, ranging from 1.5 ± 0.1 at 1 MeV to 1.6 ± 0.2 at 15 MeV. The low OER-values indicate that fast neutrons can provide an advantage in the radiotherapy of tumors containing hypoxic cells. Owing to their high penetrating power, 15 MeV neutrons are the most promising in this respect. An interpretation of the dependence of the OER from the modal energy of the neutron beams used can be given by considering the various distributions of dose in LET. Experiments in which secondary charged particle equilibrium was provided or deliberately avoided have demonstrated that with increasing neutron energy, the proton-recoil component of the energy deposition shows an increasing OER. However, with increasing of the neutrons, interactions with C, O and N nuclei play a larger part and the energy dissipated through these interactions mainly corresponds to high LET-values and low OER-values. These two phenomena result in the observed independence of the OER from the neutron energy. (auth)

49212 RADIATION-INDUCED DNA DEGRADATION IN HUMAN CELLS: LACK OF EVIDENCE FOLLOWING MODERATE DOSES OF X-RAYS. Little, John B. (Harvard Univ., Boston). Int. J. Radiat. Biol., 13: 591-5(1968).

Amnion cells were removed from human placentae by trypsinization and cultures were incubated in a medium containing ^{14}C-thymidine. Cultures were x-irradiated at a dose-rate of 75 to 120 R per min. In other experiments cells pre-labeled with ^{14}C-thymidine were incubated for eight to ten days before irradiation in non-radioactive media containing BUdR. Results showed that massive enzymatic degradation of cellular DNA did not occur and that repair processes were more likely to involve excision of isolated damaged bases. (H.L.W.)

49213 EFFECTS OF TOTAL-BODY X IRRADIATION ON HEMOLYSIN-FORMING SPLEEN CELLS IN MICE TREATED WITH BACTERIAL ENDOTOXIN. Sternick, Edward Selby. Los Angeles, Univ. of California, 1968. 136p.
Thesis.

The effects of x irradiation on the cellular hemolysin response in mice treated with bacterial endotoxin were studied. Because cellular proliferation is an indispensable feature of the immune response, a technique that measured antibody production by the critical cells, has definite advantages over methods which estimate

the antibody present in the serum. Spleen cells from animals immunized with sheep red blood cells (SRBC) were mixed with the specific antigen in a shallow agarose layer in a Petri dish, and the zones of specific antibody diffusing from the primed cells into the surrounding medium were noted as hemolytic plaques scattered throughout a sheet of intact erythrocytes. An initial experiment was performed to determine the relative depressing effects of increasing doses of x rays on the antibody-producing cells of the spleen. Mice were exposed to whole-body doses of 250R or 500R and challenged with SRBC two hours after irradiation. Observations of radiation effects were made each day for a period of 12 days following exposure to x rays. Radiation depressed the number of hemolytic plaque-forming cells. The peak response of these cells in mice exposed to 250R was delayed by one day and was lower than that of nonirradiated controls. Doses of 500 R produced a bimodal response. For the first few days following irradiation, plaque-forming cells increased to reach a small maximum; the number of these cells then decreased to a minimum on day five, before increasing again to reach a second, greater peak on day 10. The relative adjuvant effects of endotoxin given at various times before and after the injection of SRBC in nonirradiated mice were determined. Endotoxin administered before the specific antigen reduced the number of plaque-forming cells below that of the controls, whereas endotoxin administered at the same time as SRBC or one day following SRBC stimulated production of these cells. To determine whether injected endotoxin could restore the cellular hemolysin response depressed by x irradiation, mice exposed to 500R and challenged with SRBC two hours later were given 25 μg of endotoxin at various times relative to irradiation. Although animals pretreated with endotoxin showed an increased proliferation of nucleated spleen cells six to 12 days after irradiation, the number of plaque-forming cells was significantly lower than control values. Conversely, in animals treated with endotoxin two hours or one day after irradiation, a significant increase of plaque-forming cells was apparent. To discover whether the cells stimulated by pretreatment with endotoxin had a latent potential to produce hemolysin, an experiment was performed in which a second dose of endotoxin was administered at different times following irradiation with 500R and injection of SRBC. The results indicated that a second injection of endotoxin was able to antagonize the depression of plaque-forming cells. This phenomenon was most marked when the second injection was given two hours after irradiation. (Disser. Abstr.)

49214 ANTIBODY RESPONSES IN RHESUS MONKEYS EXPOSED TO WHOLE-BODY X-IRRADIATION. Reynolds, Scott L.; Craig, Charles P.; Whitford, Howard W.; Airhart, Jim; Staab, Edward V. (Army Medical Unit, Fort Detrick, Md.). Radiat. Res., 35: 451-7(1968).

The antibody responses of rhesus monkeys given attenuated Venezuelan equine encephalitis vaccine 24 hours after 400 R of acute whole-body x irradiation were studied. Hemagglutination-inhibiting (HI) and mouse neutralizing antibody titers were used as indices of the immune response. Mean HI antibody titers in irradiated monkeys were depressed at 14 and 21 days postvaccination compared with nonirradiated, vaccinated controls. Forty-two days after vaccination, comparable HI titers were observed in irradiated and control monkeys. Neutralizing antibody titers in irradiated monkeys were also lower than in controls at day 14, but by day 28 they were similar to those of the vaccine controls. (auth)

49215 LASER SOURCES FOR OXYGEN SATURATION AND DYE DILUTION STUDIES (IN VIVO). Johnson, C. C. (Univ. of Utah, Salt Lake City). pp 71-82 of Progress in Biomedical Engineering. Fogel, Lawrence J.; George, Frederick W. (eds.). New York, Spartan Books, 1967.

From Symposium on Biomedical Engineering, San Diego, Calif., June 20–22, 1966. See CONF-660660.

Two types of lasers available for possible biomedical applications are described. One is a low-power gas laser that is characterized by a gas discharge collision excitation process involving an active gas and a carrier gas which properly excites the active gas. The helium-neon laser is the most widely used gas laser. A second type of laser consists of a semiconductor junction diode, in which the active medium is the very thin junction. The semiconductor laser is excited by means of a direct current bias voltage and current. It is pointed out that the use of lasers in biomedicine goes beyond the heating applications in surgery and photocoagulation. Applications of laser sources in oximetry and dye detection are described. Oximetry refers to the process whereby oxygen saturation of the blood is measured either in vitro or in vivo. The laser technique uses a method by which light is brought into the bloodstream through a catheter filled with optical fibers and the percent of erythrocytes containing oxyhemoglobin in relation to the total number of erythrocytes is determined by the intensity of reflected light from red and infrared light sources. Blood flow measurements can be made by recording the reflected light intensity from red and infrared light sources following the injection of a blue dye (Coomassie blue) into the blood stream. Dye concentrations in the blood can be continually monitored by making a calibration measurement and observing the reflected intensity ratio. (C.H.)

49216 EFFECT ON THE ACTIVITY OF ALKALINE PHOSPHATASE OF INDICATOR QUANTITIES OF RADIOPHOSPHORUS AND RADIOGOLD. Korzhov, V. I.; Khripta, F. P. (Kiev Scientific Research Inst.). Med. Radiol., 13: No. 8, 40-2(Aug. 1968). (In Russian).

The effects on man, in particular some biochemical indexes of the blood, of the radioactivity from ^{32}P and colloidal ^{198}Au used in tracer quantities were studied. The data derived treated statistically demonstrate that the difference between the alkaline phosphatase activity in 24 hours on the 3rd to 5th day after and before administration of ^{32}P and ^{198}Au is negligible. Consequently, the tracer quantities of ^{32}P and ^{198}Au do not exert an effect on the activity of alkaline phosphatase of the blood of patients in dynamic observation (up to 5 days). (auth)

49217 METABOLISM OF PHOSPHORUS OF NUCLEIC ACIDS IN DENERVATED AND INTACT MUSCLES IN RADIATION INJURY. Zubenko, P. M.; Ostashkov, K. V.; Sokolov, I. I. (Dnepropetrovsk Medical Inst., USSR). Med. Radiol., 13: No. 8, 44-8(Aug. 1968). (In Russian).

The content and metabolism of phosphorus of nucleic acids (DNA and RNA) in rabbit denervated muscles induced by the action of whole-body single 1200 R doses of x radiation were studied. Radioactive tracer techniques were used. It was found that at later periods after denervation in the skeletal muscles there occurred a relative increase of the level of RNA and DNA and a reduction of the intensity of phosphorus metabolism. Whole-body single irradiation caused a decrease in the content of nucleic acids in intact muscles, both in the initial period (16 to 20 hours after irradiation) and at the peak of radiation sickness (10 to 12 days). The rate of DNA and RNA phosphorus metabolism increased. In denervated muscles radiation produced no essential changes in the content and metabolism of nucleic acid phosphorus. The data derived testify to the participation of the central nervous system in the reaction of the muscular tissue to the effect of ionizing radiation. (auth)

49218 GROWTH OF MOUSE FIBROBLASTS IN THE PRESENCE OF IRRADIATED AND LYOPHILIZED MONOLAYERS OF THE SAME TYPE OF CELLS. Schutz, Leonard (Univ. of California, La Jolla); Mora, Peter T. J. Cell. Physiol., 71: 7-16(Feb. 1968).

Why certain cells, such as 3T3 mouse embryo fibroblasts, are inhibited from dividing when they grow to a characteristic cell density on a surface in tissue culture was studied. Whether the inhibition could be attributed to the inert chemical composition of neighboring cells was examined, that is, whether the residues of lyophilized cells retain the ability to inhibit the division of normal cells. Whether cells in which DNA synthesis was impaired by irradiation retain the capacity to effectively inhibit normal cells was also tested. The irradiated cells were exposed to 10,000 rad from 2.5-MeV electrons produced by a Van de Graaff generator. Pulse labeling with tritiated thymidine was used to follow the cell division (DNA synthesis) at periodic intervals. Fresh 3T3 cells were then added to lyophilized or irradiated layers and their growth was followed. There was no growth of added cells on the confluent monolayers of either untreated or irradiated cells. Growth was unimpeded on the monolayers of lyophilized cells. When cells were added to nonconfluent cultures of either normal or irradiated cells the added cells grew until they had covered the remaining surface of the culture dish and had come into contact with the pre-existing cells. The role of available surface over which the cells can spread, as well as to the possible interactions between neighboring cells, was discussed. (BBB)

49219 RADIOSENSITIVITY OF DNA SYNTHESIS AND MITOSIS IN HARDING–PASSEY MELANOMA AND IN THE SMALL INTESTINE OF MICE: BIOCHEMICAL AND AUTORADIOGRAPHIC STUDIES WITH RADIOACTIVE THYMIDINE. Hempel, Klaus (Univ., Wuerzburg, Ger.). Biophysik, 4: 356-69(1968). (In German).

Mice with Harding-Passey melanomas were injected with ^{3}H-thymidine between 30 min and 52 hr after whole-body x irradiation (545 R and 1000 R). The animals were sacrificed 1 hr after the injection, and the radioactivity of DNA from small intestine and melanoma was measured. The synthesis of DNA decreased within the first 15 hr after irradiation to 10 to 20% of the control value in small intestine as well as in melanoma. In the following hours

both tissues clearly recuperated and on the second day after irradiation DNA synthesis was equal to or greater than that in the controls. Autoradiographic investigations of the same material showed that the decrease in DNA synthesis in the melanoma was primarily caused by a reduction in the number of DNA-synthesizing cells, while in the small intestine the rate of DNA synthesis per cell was also considerably lower. After irradiation with 545 R no mitoses were observed in melanomas for 25 to 30 hr. In contrast, the inhibition of mitosis only lasted 10 to 15 hr in the small intestine. A mitotic index equal to that of the controls was reached by neither tissue until the 3rd day. The main difference in the reaction to irradiation between melanocytes and epithelial cells in the small intestine was that 20% of all epithelial cells in the crypts died within the first 24 hr after irradiation (545 R). Under these conditions melanocytes showed no considerable changes in their morphology. It could be shown by autoradiographic experiments that the radiation sensitivity of intestinal epithelial cells remains similar during all phases of the cell cycle. That melanocytes from the Harding-Passey melanoma are less sensitive to irradiation is, in total, not due to a lower sensitivity of DNA synthesis or mitosis; rather, greater irradiation resistance of other reactions which are more important for survival must be responsible. (auth)

49220 CIRCADIAN RHYTHMICITY IN THE EFFECT OF IRRADIATION ON THE ENDOGENOUS COLONY FORMATION IN THE SPLEEN OF IRRADIATED MICE. Vacek, A.; Davidova, E.; Druzhinin, Yu.; Hosek, B.; Chlumecky, J. (Inst. of Biophysics, Brno. Institut Mediko-Biologicheskikh Problem, Moscow). Int. J. Radiat. Biol., 13: 539-48(1968).

Mice, adapted to cyclic change of light and darkness (12 hours light, 12 hours darkness) were irradiated at different times within the 24 hours. It was observed that after irradiation during the day (14 hours) the number of endogenous colonies in the spleen was higher than that after irradiation at night (20 hours). The lowest number of colonies in the spleen was observed following irradiation 1 hour after the change of light cycle (8, 20 hours). The dose-survival curves for colonies had higher numbers of colonies at 14 hours than that at 8 hours, but the D_0 was similar at both times. The transplantation of bone-marrow and spleen cells indicated a higher colony forming ability for cells from adapted mice killed in the middle of the day, than from those killed soon after change of light cycle. The changes in rectal temperature and oxygen consumption of adapted mice followed a contrary course as compared with changes in the number of colonies in spleen after irradiation at different times of the day. The lowest temperature and O_2 consumption was estimated during the day, and the highest values early after the change of light cycle. The possibility is considered of humoral induction of changes in the state of haematopoietic stem cells within the 24 hours that may cause the observed differences in the number of endogenous colonies in the spleen of mice irradiated at the various times of the day. (auth)

49221 THE MODIFICATION OF THE HOMOTRANSPLANT REACTION BY EXTRACORPOREAL IRRADIATION OF THE BLOOD IN THE RAT AND DOG. Pichlmaier, H.; Trepel, F. W. (Univ., Munich). Arch. Klin. Chir., 316: 537-41(1966). (In German).

Results following extracorporeal x irradiation at a dose of 1000 R of blood from 200 rats and dogs that had been subjected to homologous skin transplantation are reported. Exposure times were 20 min for rat blood and 40 to 60 min for dog blood. Development of a homotransplant reaction was inhibited in the animals. When the irradiation was performed during the peak of the efferent immunological reaction, the inhibition was greatest. The significant immunological effect of the extracorporal blood irradiation was exhibited as a greater sensitivity of the small clear plasma lymphocytes toward x irradiation, as compared to basophilic lymphocytes. It was conjectured that this does not indicate the presence of two groups of cells that differ in their radiosensitivity, but that small lymphocytes appear as clear plasma cells during a certain phase of development when they are relatively more sensitive to irradiation. (BBB)

49222 COMPREHENSIVE BIOCHEMISTRY. VOLUME 27. PHOTOBIOLOGY, IONIZING RADIATIONS. Florkin, Marcel; Stotz, Elmer H. (eds.). New York, American Elsevier Publishing Company, Inc., 1967. 400p. $20.00.

The interaction of electromagnetic radiation and biological material is the general subject of the eight chapters in this volume. Separate abstracts were prepared for the chapters on ultraviolet radiations and photoreactivation, and radiation effects on macromolecules. Other chapters are on phototropism, biochemistry of visual processes, bioluminescence, photosensitization, phytochrome and photoperiodism, and photosynthesis. (M.M.B.)

For abstracts of individual chapters see: 49223 and 49224.

49223 EFFECTS OF ULTRAVIOLET RADIATION AND PHOTOREACTIVATION. Setlow, Jane K. (Oak Ridge National Lab., Tenn.). Contract W-7405-eng-26. pp 157-209 of Comprehensive Biochemistry. Vol. 27. Photobiology, Ionizing Radiations. Florkin, Marcel; Stotz, Elmer H. (eds.). New York, American Elsevier Publishing Company, Inc., 1967. (ORNL-P-1364).

The molecular basis for the effects of uv radiation on biological systems and the repair of these effects are reviewed. Enzymes are inactivated by uv-induced damage to aromatic amino acids and tryptophan and particularly cystine. Breakage of peptide bonds is of little or no importance in this process at wavelengths of 2200Å. Energy absorbed in one amino acid does not appear to induce a photochemical alteration in another, although energy transfer does occur in proteins, and enzymes can be protected against uv inactivation by attached dyes that dissipate absorbed energy by fluorescence. Protein damage does not appear to be important in uv-induced killing of bacteria except possibly of Micrococcus radiodurans. There is no evidence for energy transfer in nucleic acids. Among many uv-induced changes in DNA only pyrimidine dimer formation has been clearly connected with biological effects. Dimers block DNA synthesis by bacteria and inactivate purified transforming DNA, but it has not been shown that they result in mutation (the mechanism for uv-induced mutation remains unknown). Dimers can apparently be produced by any pair of pyrimidine residues. Repair of pyrimidine dimer damage occurs when dimers are monomerized by photoreactivating enzyme in the presence of light or when they are excised. The excised dimers may appear in the acid-soluble fraction in some cellular systems or in others in the external medium or in large non-acid-soluble oligonucleotides. 254 references. (M.M.B.)

49224 EFFECTS OF IONIZING RADIATIONS ON BIOLOGICAL MACROMOLECULES. Alexander, Peter; Lett, John T. (Royal Cancer Hospital, London). pp 267-356 of Comprehensive Biochemistry. Vol. 27. Photobiology, Ionizing Radiations. Florkin, Marcel; Stotz, Elmer H. (eds.). New York, American Elsevier Publishing Company, Inc., 1967.

The chemical changes produced in cellular macromolecules by ionizing radiations are reviewed. The subjects covered are the interaction of radiations with matter, direct and indirect action, the role of metabolism in radioinduced injuries, changes in proteins, effects on polysaccharides, damage to nucleic acids, and effects on nucleoproteins, viruses, and cells. 174 references. (M.M.B.)

49225 THE EFFECT OF RADIATION ON ^{47}Ca, ^{85}Sr, AND MUCOPOLYSACCHARIDE METABOLISM IN THE RAT INTESTINE. Glaubitt, D. (Eppendorf University Hospital, Hamburg). Monogr. Nucl. Med. Biol., No. 1, 452-61(Feb. 1968).

From Gastrointestinal Radiation Injury Symposium, Richland, Wash. See CONF-660917.

The kinetics of ^{47}Ca, ^{45}Ca, and ^{85}Sr in the whole rat and in rat organs, and the concentration of mucopolysaccharides in the intestinal contents, were examined after whole-body x irradiation of male rats. The biological half-time of the isotopes was lengthened following irradiation. Hyaluronic acid and chondroitin sulfates increased in concentration two days after irradiation and five days later decreased below the pre-irradiation level. The concentration of heparin did not appear to be affected by irradiation. A relation between Ca and Sr metabolism and mucopolysaccharide metabolism was not demonstrated. (M.M.B.)

49226 DIFFERENTIAL EFFECTS OF IRRADIATION ON GASTRIC ACID AND BIOELECTRIC POTENTIAL IN THE RAT. Vaughan, B. E.; Cummins, J. T.; Ridley, H. A. (Naval Radiological Defense Lab., San Francisco). Monogr. Nucl. Med. Biol., No. 1, 242-50(Feb. 1968).

From Gastrointestinal Radiation Injury Symposium, Richland, Wash. See CONF-660917.

Studies on the effects of x radiation on electrical and acid activities of rat stomachs are reviewed and measurements of strong acid secretion rates in situ are reported. Isolated stomachs were tested for bioelectrical activity, acid secretory rate, adenosine triphosphate (ATP), phosphocreatine, lactate, and protein concentrations at various times after irradiation. Only bioelectrical activity showed an appreciable radiation effect. The inhibition of bioelectrical activity by acetylcholine did not appear to be related to the radiation effect. The sodium transport system appeared to be resistant to a significant amount of direct radiation damage. It is suggested that independent injury to the sodium transport system may occur. (M.M.B.)

49227 STUDIES ON DNA METABOLISM IN ISOLATED PERFUSED INTESTINE OF NORMAL AND X-IRRADIATED RATS. Gerber, G. B. (EURATOM, Mol, Belg. Center for Nuclear Energy Studies, Mol, Belg.). Contract 053-64-3-BIO. Monogr. Nucl. Med. Biol., No. 1, 159-66(Feb. 1968).

From Gastrointestinal Radiation Injury Symposium, Richland, Wash. See CONF-660917.

A method for the perfusion of the isolated intestine is described and data on incorporation and catabolism of thymidine, deoxyuridine, and deoxycytidine in normal and x-irradiated intestine of rats are presented. It was demonstrated that the isolated perfused intestine is a useful system for quantitative studies of DNA metabolism. The catabolism of pyrimidines increased markedly with the concentration of precursors but was not affected by irradiation. Incorporation of precursors into DNA decreased after whole-body irradiation, and to a lesser extent after local irradiation. (M.M.B.)

49228 MOVEMENT OF DISCRETE PARTICLES IN THE 100- TO 200-MICRON DIAMETER RANGE THROUGH THE GASTROINTESTINAL TRACT OF LABORATORY ANIMALS AND MAN. Richmond, C. R.; Furchner, J. E. (Univ. of California, Los Alamos, N. Mex.). Monogr. Nucl. Med. Biol., No. 1, 498-509 (Feb. 1968).

From Gastrointestinal Radiation Injury Symposium, Richland, Wash. See CONF-660917.

A study was made of the time required for particles to pass through the gastrointestinal tract of man and animals and of residence times in different portions of the tract. Ceramic microspheres labeled with either ^{54}Mn or ^{46}Sc, and $^{235}UC_2$ fuel cores were used. Fecal samples were measured with γ-ray spectroscopy and assays were made of portions of the gastrointestinal tract of animals (dogs, mice, and rats) sacrificed hourly. The implications of the results for estimations of radiation dose are discussed. (M.M.B.)

49229 FINE STRUCTURE OF THE INTESTINAL EPITHELIUM AFTER 3 KRADS OF X RAYS. Hampton, J. C. (Northwestern Univ. Medical School, Chicago). Contract AT(11-1)-1244. Monogr. Nucl. Med. Biol., No. 1, 13-26(Feb. 1968).

From Gastrointestinal Radiation Injury Symposium, Richland, Wash. See CONF-660917.

Changes occurred in the fine structure of the villus and crypt epithelial cells of mice given 3 kRad whole-body x irradiation. After three to five days the animals usually died. Both proliferating and postmitotic differentiating cells were affected. Ribosomes were depleted after irradiation. Radioinduced changes in both villus and panette are illustrated with light and electron micrographs. (M.M.B.)

49230 EFFECT OF HOMOLOGOUS HEMOPOIETIC TISSUE TRANSPLANTATION ON THE EFFICACY OF SEROPROPHYLAXIS OF DIPHTHERIA INTOXICATION IN LETHALLY IRRADIATED GUINEA PIGS. Kaulen, D. R. (Inst. of Epidemiology and Microbiology, Moscow). Zh. Mikrobiol., Epidemiol. Immunobiol., No. 6, 142-6(June 1968). (In Russian).

A study was made of the effect of hemopoietic tissue transplantation obtained from homologous normal donors, on the efficiency of seroprophylaxis of diphtheria intoxication in lethally γ irradiated (600 R) guinea pigs. Reduction of passive immunity intensity was associated with development of radiation sickness. At this period transplantation of homologous hemopoietic tissue compensated the passive immunity disturbances. The degree of compensation was in direct relationship to the number of transplanted cells. The data obtained offer a possibility of considering that the hemopoietic tissue cells of a donor (chiefly lymphoidal ones), transplanted to an irradiated recipient, participate in reproducing passive immunity in the latter. (auth)

49231 RATE OF PRODUCTION OF SINGLE-STRAND BREAKS IN DNA BY X-IRRADIATION IN SITU. Freifelder, David (Brandeis Univ., Waltham, Mass.). J. Mol. Biol., 35: 303-9(July 28, 1968).

The rate of production of single-strand breaks by x irradiation of DNA in situ was studied in Escherichia coli, the assay for single-strand breakage being the conversion of covalent circles of F' Lac DNA to nicked circles. This rate was 2.73×10^{-3} single-strand break/RAD/E. coli genome. When related to survival levels of x irradiated E. coli B_{s-1}, it was found that there are 7.4 single-strand breaks per lethal hit, from which it is concluded that if single-strand breaks are not repaired in strain B_{s-1}, then the production of single-strand breaks is probably not lethal. It is hypothesized that a major lethal event is a double-strand break. It has been found that isolated DNA is 15 times as sensitive to x ray-induced single-strand breakage as DNA in situ. (auth)

49232 REPORT ON THE INDUSTRIAL USES OF RADIATIONS. Koizumi, I. Genshiryoku Shiryo, No. 3, 1-48(June 1967). (In Japanese).

An investigation was made by the Atomic Energy Bureau of STA, as of March 1966, on the uses of radiations by the nation's various enterprises. The purpose of this investigation was to make clear the state of such uses in Japan, and study problems for the future, thereby promoting their utilization in the industries. Among the major uses of radioisotopes were those of gauging, radiography, tracer and irradiation treatment; others included removal of static electricity, luminous paint, etc. The number of instruments with sealed sources was 931, against 576 four years before; the increase was mainly in gaugings. For the radioactive tracers, 68 nuclides, against 25 four years before, were employed, showing an extensive utilization of radioisotopes in this field. A total of over 350 enterprises used radiations, against 318 four years before. More radioisotopes (or radiations) were employed in the industries of petroleum and coal products, iron and steels, electric power and gases, and pulp and paper. Among the radiation generators, the betatron and the Cockcroft–Walton's apparatus were most used. As the result of the investigation, it was revealed that Japan was still behind other advanced countries in the field of RI (and radiation) uses; there was need to take measures necessary to promote their utilization. (NSA of Japan)

49233 RADIATION EFFECTS UPON WATER ABSORPTION AND EXCRETION IN THE RAT. Rohwer, Paul Stirling. Rochester, N. Y., Univ. of Rochester, 1967. 135p.

Thesis.

Whole-body x-irradiation was found to have a significant effect on gastrointestinal absorption of tritiated water in the rat. Following a 375 R exposure, there was a significant enhancement of tritiated water absorption immediately after the exposure (day 0) and a slight impairment of absorption on days 1, 2, and 3 with minimal absorption being observed on the third day. With an exposure of 750 R, there was no significant alteration of tritiated water absorption on day zero. At that exposure, however, absorption of tritiated water was significantly impaired on days 1, 2, and 3 post-irradiation. The impairment increased steadily with minimal absorption occurring on day 3. The fourth post-irradiation day was characterized by an abrupt recovery with tritiated water absorption returning to control levels. No alteration in tritiated water absorption was observed beyond day 3 in the 21 day post-irradiation period studied. Following a 1500 R exposure, the absorption of tritiated water was even less than that seen in rats irradiated with 750 R. With the supralethal exposure, this impairment increased steadily until death of the animals ensued. Thus, the impaired absorption of tritiated water observed on the third day post-irradiation was shown to be exposure dependent over the range studied, with the impairment at 375 R not being statistically significant. The biological half-life of tritiated water in the rat was found to be relatively insensitive to whole-body radiation exposures up to 750 R. A slight, but statistically significant, increase in the biological half-life was found when the tritiated water was given 24 hours after the 750 R exposure. Radiation induced alterations in water intake and urine output were observed in the post-irradiation period. The values of the two parameters usually paralleled each other, with both the pattern and the magnitude of the response being exposure dependent. The patterns of post-irradiation body weight change were exposure dependent and in good agreement with those previously documented. (Disser. Abstr.)

49234 FIXATION AND LIBERATION OF AMMONIA IN THE BRAIN OF WHITE RATS IN CONNECTION WITH X-RAY IRRADIATION. Pikulev, A. Ts., Asipchyk, T. K. Vestsi Akad. Navuk BSSR, Ser. Biyal. Navuk, No. 4, 75-9(1966). (In Russian).

After general x-ray irradiation of white rats in a dose of 40 R, changes were noted in the ammonia-glutamine system. The amount of ammonia rose significantly within two hours after the effect of ionizing radiation. The glutamine content showed a tendency to rise in all periods after irradiation, reaching a maximum increase over the level established in the control after seven days. The activity of glutaminase in individual subcellular fractions changes variously: in the low-speed fraction the changes have a phasic character. In the mitochondria the speed of fermentative hydrolysis of ammonia is reduced at all intervals after the effect of ionizing radiation, except for the fifth day. In the hyaloplasmic and microsomic fluid glutaminase activity increases both in the early and late intervals after irradiation. (JPRS)

49235 EFFECTS OF IONIZING RADIATION ON ENDOGENOUS RESPIRATION OF BACILLUS CEREUS SPORES. Desser, H.; Broda, E. (Univ., Vienna). Int. J. Radiat. Biol., 13: 597-600 (1968). (In German).

Spores were suspended in distilled water and irradiated with a ^{60}Co source and then plated on agar in Petri dishes. After 16 hrs of incubation at 30°C it was found that the number of colonies developing from irradiated spores was reduced by one tenth as compared with controls. For respiration studies, spores were irradiated in water and respiratory quotients were determined by measuring CO_2 in a gas counter. With increasing doses of radi-

ation the respiration increased up to a maximum and then decreased. The irradiated spores were subjected to a temperature range of 30 to 70°C; maximum respiration occurred at 40°C. It is suggested that the radioinduced increase in metabolism is caused by an increase in intracellular permeability. (H.L.W.)

49236 FRACTIONAL COMPOSITION AND THYROXINE BINDING CAPACITY OF BLOOD SERUM PROTEINS DURING γ IRRADIATION. Turakulov, Ya. Kh.; Ablyaeva, N. Kh.; Bekhmukhamedova, Z. U. (Inst. of Biochemistry, Tashkent). Med. Radiol., 13: No. 4, 32-4(1968). (In Russian).

The fractional composition and thyroxine-binding-capacity of blood serum proteins was studied in male rats exposed to a single 400-R total-body dose of ^{60}Co γ radiation. During the critical stages of radiation sickness (5 to 15 days after exposure) the albumin level dropped 22 to 49%, but the globulin fraction increased. It was concluded that radioinduced alterations in composition of blood fractions inhibited the capacity for specific binding of thyroxine. (R.V.J.)

49237 RADIOSENSITIZATION OF BRAIN TUMOR CELLS WITH A THYMIDINE ANALOGUE (BROMOURIDINE). Sano, Keiji; Hoshino, Takao; Nagai, Masakatsu (Tokyo Univ.). J. Neurosurg., 28: 530-8(June 1968).

Five-bromo-2′-deoxyuridine (bromouridine or BUdR) sensitizes bacterial or tumor cells to irradiation and can be incorporated into the nuclei of human brain tumor cells cultured by the trypsinization monolayer method. The BUdR had neither antimetabolic nor cytocidal effect but was shown to increase the radiosensitivity of the cells that took it up. Uptake of BUdR had neither antimetabolic nor cytocidal effect but was shown to increase the radiosensitivity of the cells that took it up. Uptake of BUdR into the tumor cell nuclei in tissue culture was enhanced by addition of a small amount of antimetabolites such as Methotrexate, 5-fluorouracid (5-FU), or 5-fluoro-2′-deoxyuridine (FUdR). This was explained by the hypothesis that the antimetabolites inhibited the biosynthesis of thymidine and thus forced dividing cells to incorporate the newly arrived thymidine analogue (BUdR) to duplicate their DNA. A clinical trial was conducted of BUdR-antimetabolite-continuous intra-arterial infusion-radiation therapy (BAR therapy) for malignant brain tumors. Therapy included administration of BUdR, 600 to 1000 mg/day with a small amount of antimetabolite (1 to 5 mg of Methotrexate or 3 to 5 mg of 5-FU) by continuous intra-arterial infusion for a period longer than the estimated generation time of the brain tumor cells (four to seven weeks), and combined irradiation. Evaluation of the results will require long-term follow-up. (BBB)

49238 COMPARATIVE STUDY OF IODINE COMPLEXES OF IRRADIATED POTATO STARCH AND INDUSTRIALLY MODIFIED STARCHES. Korotchenko, K. A.; Putilova, I. N.; Maslova, G. M. (Technological Inst. of the Food Industry, Moscow). Sakh. Prom., 12: 44-8(Dec. 1966). (In Russian).

Potato starch, corn starch, and acid-released dextrin were irradiated with 10 to 50 MR total doses by a ^{60}Co γ-ray source, and examined by microphotography and chromatography. They revealed that radiation induced destructive processes in starches, namely, decreased degree of polymerization and decreased viscosity. Potato and corn starches exposed to 30 MR acquired increased solubility and conglutination properties, and at the 50-MR radiation dose they became converted into molecular sizes corresponding to industrial acid dextrin. To follow iodine-induced color changes in irradiated starches, water extracts of the starches were treated with iodine, then desiccated within 4 hr at 120°C, and subsequently irradiated with doses of 10 to 50 MR of ^{60}Co γ rays. It was found that the iodine color intensity increased with increasing doses of radiation, e.g. 10 to 20 MR doses produced a bluish-violet color and 20 to 50 MR doses yielded a reddish-violet color. The experiments demonstrated that specific iodine color effects of industrially modified starches can be obtained either by certain radiation doses or by varying the moisture content of the starches. (BBB)

49239 SIMILARITIES AND DIFFERENCES IN THE BIOCHEMICAL EFFECTS OF RADIATION AND RADIOMIMETICS. Savitskii, I. V.; Borisova, A. S.; Zelinskii, V. G.; Musiiko, V. A.; Levitskii, A. P.; Tsybulskii, V. V. (Odessa Medical Inst.). Radiobiologiya, 7: 840-5(1967). (In Russian).

The early effects of radiation and radiomimetics on the enzyme activity in white rats and rabbits were investigated. The animals were irradiated at doses of 600 to 800 and 900 R respectively at 27.7 and 9 R/min, respectively; others were administered the LD_{50} of radiomimetics intravenously (12.4 mg/kg of embitol, 15 mg/kg of thiophosphamide, and 12 mg/kg of sarcolysine). The investigated enzymes were dehydrogenase, transaminase, hexokinase, aldolase, alpha-amylase, alpha-glucanphosphorase, arylesterase, aliesterase, lipase and enzymes of methylated guanidine acetate. It was found that a characteristic feature of the early effect of radiation on those enzymes was considerable reduction of the activity, especially those requiring preservation of the integrity of the intracellular structures. The radiomimetics imitated the effect of radiation only with enzymes requiring preservation of the cellular structure or supply of energy. (JPRS)

49240 THE EFFECT OF α-METHYLDOPA AND ULTRAVIOLET IRRADIATION OF MELANOGENESIS. Mishima, Y.; Tanay, Antoinette (Wayne State Univ., Mich.). Dermatologica, 136: 105-14(1968).

Changes of melanogenic activity were studied as affected by uv irradiation in the human melanocyte after blocking alternate pathways of tyrosine metabolism by the systemic administration of α-methyldopa. This experiment was also designed to determine the effect of uv irradiation on the population of dopa-positive melanocytes, a currently disputed problem. White male volunteers 30 to 55 yr of age were exposed over an area $3\frac{1}{2} \times 3\frac{1}{2}$ cm^2 of the back with a hot quartz lamp (type QA-450) having wavelength of 2400 to 3200 Å with greatest radiation in the region from 2800 to 3200 Å. Systemic administration of α-methyldopa increased the number of dopa-positive melanocytes in the uv-irradiated human skin as compared with control and uv irradiation alone. However, α-methyldopa in the absence of uv irradiation revealed only slight effect on the population of dopa-positive melanocytes. In contrast to some previous reports, this evidence indicates that uv irradiation itself increases the population of dopa-positive human melanocytes. As a mechanism of the increased melanogenesis after α-methyldopa administration, the effect of an increase of available substrate molecules on the synthesis and activity of tyrosinase is discussed. Administration of α-methyldopa may increase tyrosinase activity not only in melanocytes which are already dopa positive, but even in those enzymically inactive melanocytes that were formerly dopa negative. This increased tyrosinase activity becomes distinctly observable in the accelerated melanogenesis induced by irradiation. (BBB)

49241 DERMAL CONNECTIVE TISSUE ALTERATIONS WITH AGE AND CHRONIC SUN DAMAGE. Smith, J. Graham Jr. (Medical Coll. of Georgia, Atlanta); Finlayson, G. Rolland. J. Soc. Cosmet. Chem., 16: 527-35(1965).

Effects of solar uv radiation on skin and its individual constituents are reviewed (45 references) and compared with aging effects. Histological and biochemical alterations in aging and sun-damaged human dermis (actinic elastosis) are quite different. Aging changes are characterized by decreases in nonfibrous protein, acid and neutral mucopolysaccharides, and slight increases in the fibrous proteins, collagen and elastin. Ultraviolet-damaged skin (actinic elastosis) shows marked increases in acid and neutral mucopolysacchride and elastin with decreased amounts of collagen. Hypotheses based on some recent studies are offered to explain the effects. Lysosomes in fibroblasts are labilized by heat and uv light below 3100 Å, so that the labilization of these particles with release of collagenase leads to the digestion and thus reduction of the amount of collagen in the dermis following sun exposure. There are enzymes in lysosomes which degrade mucopolysaccharides, and hyaluronic acid is also depolymerized by uv light below 3100 Å. The increase of hyaluronic acid may be a function of enzymatically degraded mucopolysaccharides being recycled metabolically while the collagen subunits are not. The lack of elastolytic enzymes in lysosomes as well as the lack of any direct effect of uv light (2900 to 3200 Å) in degrading either collagen or elastin in vitro could explain the increase in elastic tissue found in this disorder as new connective tissue, collagen and elastin, is synthesized to replace the digested collagen. It is not known if uv light in the crucial range of 2900 to 3100 Å labilizes lysosomes. (BBB) (TSS)

49242 INCORPORATION OF URANIUM. II. DISTRIBUTION OF URANIUM ABSORBED THROUGH THE LUNGS AND THE SKIN. Walinder, G. (Research Inst. of National Defence, Sundbyberg, Sweden); Fries, B.; Billaudelle, U. Brit. J. Ind. Med., 24: 313-19(1967).

In mice, rabbits, and piglets the distribution of U was studied at different times after exposure. Uranium was administered by inhalation of U_3O_8 aerosols (mice) and through the skin (rabbits and piglets). The uptakes of U in different organs of the three species were highly dependent on the amounts administered. There seemed to be a saturation effect in the spleen and bone tissue whenever the U concentration in the blood exceeded a certain level. The effect in the kidney was entirely different. If, in a series of animals, the quantity of U was continuously increased, the uptakes by the kidneys increased more rapidly than the quantities administered. This observation was consistent with the toxic effects of U on the capillary system in the renal cortex. Polyphloretin phosphate, a compound that reduces permeability, was investigated with respect to its effect on the uptake of U deposited in skin wounds in rabbits and piglets. It significantly reduced the absorption of U, even from depots in deep wounds. The findings

are discussed with reference to the routine screening of persons exposed to U at AB Atomenergi. (BBB)

49243 ON THE ROLE OF METAL CATIONS IN CELLULAR ADHESION: CATION SPECIFICITY. Armstrong, Peter B.; Jones, Daniel P. (Univ. of California, Davis). J. Exp. Zool., 167: 275-82(Mar. 1968).

The role of Mg, Ca, Sr, and Ba ions in adherence of cells of embryos of Hyla regilla, Rana pipiens, and Xenopus laevis was studied. Of these 4 common alkaline earth cations, only Ca^{2+} was able to protect Rana embryos from dissociation of the epidermis into isolated cells by EDTA (ethylenediaminetetraacetic acid). Presumably this is because only Ca^{2+} is able to satisfy the divalent cation requirement for cellular adhesion in this tissue. Although early stage embryos are completely dissociable by EDTA, the axial musculature, brain, and spinal cord become resistant to dissociation by stage 17. Strontium was partially effective in preventing cell disaggregation, but wound healing in Sr-EDTA (20 mM Sr−10 mM EDTA) was limited to a rounding off of the cut edges of the wound. Wounds were stabilized in this configuration. The borders of wounds made in embryos immersed in Mg EDTA or Ba EDTA showed signs of cell disaggregation within a few minutes. Embryos could heal very small epidermal wounds in 1 mM Mg EDTA, Sr EDTA, and Ba EDTA as long as there was minimal disturbance of the wound borders. Treatment of embryos with Mg-, Sr-, or Ba-EDTA presumably results in removal of Ca from the embryo by formation of the Ca-EDTA complex and the concomitant liberation of free Mg, Sr, or Ba. That various alkaline earth cations besides Ca^{2+} support reaggregation of at least some cell types suggests that the permeability properties of the plasma membrane are not involved with adhesion, as Mg, Sr, and Ba are not able to replace Ca in maintaining membrane impermeability. (BBB)

49244 EFFECT OF PANCREATIN ON THE ABSORPTION OF ^{59}Fe IN RATS WITH FATTY LIVER. Murray, M. L.; Stein, N. (Univ. of Minnesota, Minneapolis). Amer. J. Dig. Dis., 13: 527-9(June 1968).

Administration of a single dose of pancreas extract along with ^{59}Fe to rats pretreated with ethionine has been reported to reduce the expected increase in absorption of the isotope. This was not, however, a physiological experiment, as the ^{59}Fe was premixed with the pancreatic extract, which may permit nonspecific in vitro binding of ^{59}Fe. A controlled feeding experiment was conducted to study the effects of pancreatin on the increased uptake of ^{59}Fe seen in rats with fatty liver induced by choline deficiency. Choline-free diets began the day before administration of ^{59}Fe, but the rats were fasted overnight. The following morning they were each given an intragastric dose of 0.25 μCi of ^{59}Fe as ferrous citrate with 0.25 mg of ferrous citrate as a carrier. Total-body radioactivity was determined immediately and 10 days later. The mean absorption of ^{59}Fe in healthy untreated rats ranged from 2.5 to 4%. Neither pancreatin nor bromelin treatment had a significant effect on depressing the absorption of ^{59}Fe as ferrous citrate in rats with fatty liver. (BBB)

49245 INHIBITION OF THE ABSORPTION OF DIETARY RADIOSTRONTIUM BY ALUMINIUM PHOSPHATE GEL AND SODIUM ALGINATE IN THE RAT. Carr, T. E. F.; Nolan, J. (Medical Research Council, Harwell, Eng.). Nature (London), 219: 500-1(Aug. 3, 1968).

Phosphate gel has been shown to significantly inhibit absorption of radiostrontium in man when fed with a low calcium diet. The intestinal absorption of radiocalcium and radiostrontium is much influenced by experimental conditions, however, and a comparison of the efficiency of the phosphate gel and high guluronic acid alginate from published data proved difficult. The present communication describes a comparative study under carefully controlled conditions in the rat. Tracer doses of ^{45}Ca and ^{85}Sr were used in the study, and assayed in the urine, faeces, gut and carcass. Results are tabulated. Both additives very significantly decreased ^{85}Sr absorption, the sodium alginate (containing 97% guluronic acid) being more effective on a weight for weight basis. When both additives were used together the reduction of ^{85}Sr absorption was greater than for either alone. (UK)

49246 THE KINETICS OF ACCUMULATION AND ELIMINATION OF ORALLY ADMINISTERED ^{90}Sr. Moskalev, Yu. I.; Buldakov, L. A. (Inst. of Biophysics, Moscow). Health Phys., 15: 229-35(Sept. 1968).

The uptake, distribution, and retention of ^{90}Sr was determined in rats and dogs during and after a period of prolonged administration. Groups of rats either 1, 4, or 7 months old initially were fed either 5×10^{-4} or 1×10^{-2} μCi ^{90}Sr per day for periods ranging from about 200 to 600 days. Dogs, 1 and 2 yr old, were fed 0.01 μCi ^{90}Sr for over 1000 days. After the cessation of ^{90}Sr feeding body burdens were determined in both species for an additional 100 to 500 days. Skeletal ^{90}Sr concentrations were 10 to 1000 times greater than concentrations found in soft tissues. In rats, body burdens reached a dynamic balance between accumulation and elimination after about 4 months of ^{90}Sr administration in rats started at 1 to 1.5 months of age, and in about 1 yr in rats which were 4 months old at the start of the experiment. In dogs, a constant body burden was achieved after about 17 months of ^{90}Sr feeding. The strontium accumulation multiple (body burden/daily intake) ranged between 7 and 10 in adult rats and was 17 in the 1.5-month-old rats. The accumulation multiple for dogs did not exceed 44. After 2.8 yr on the strontium-containing diet, the dog skeletons were reasonably uniformly labeled and minimal and maximal strontium concentrations in individual bones did not differ by more than a factor of 1.8. Elimination of ^{90}Sr was described by exponential models whose maximum effective half-life in rats ranged between 533 and 593 days; in dogs it was calculated to be 530 days. A prediction equation was derived, which enabled calculation of the accumulation multiple as a function of duration of administration and the influence of age on strontium metabolism. (auth) (UK)

49247 STUDIES ON X-AGENT. LV. FURTHER STUDIES ON THE INTERACTION OF HEAT RADIATION AND X-AGENT. Moriyama, Hideo (Shonan Hygiene Inst., Kamakura, Japan). Yokohama Med. Bull., 18: 117-26(Aug. 1967).

Temporal variations in transmittance of tungsten-emitted light through dye solution were studied in relation to variations in related phenomena associated with x-agent, a hypothetical cosmic radiation. Investigations were performed on the effect of ordinary electric lamp light on the direction-patterns obtained with alkaline neutral-red solutions in the early spring of 1967. The effect of the light was found to be generally the same during the period, unlike that seen during a previous period (1963). The radiation of interest in the light was heat radiation. The water contained in the bottle around which the pigment solutions were arranged did not affect the pattern formation. The pattern was developed only by the heat radiation contained in the light. The pigment solutions exposed to the heat radiation appeared to become discolored; however, the discoloration-preventing action of the heat radiation was not always demonstrable. An X agent is postulated as necessary for the heat radiation to act in this way. (BBB)

49248 STUDIES ON X-AGENT. LIV. THE LIGHT-EFFECT ON THE DIRECTION-PATTERN FORMED BY X-AGENT IN PIGMENT SOLUTIONS ARRANGED AROUND A BOTTLE OF WATER WITH SPECIAL REFERENCE TO THE GREAT CHANGE OBSERVED WITH X-AGENT AROUND 1965. Moriyama, Hideo (Shonan Hygiene Inst., Kamakura, Jap.). Yokohama Med. Bull., 18: 73-84(June 1967).

Temporal variations were found in the direction-pattern of light transmittance intensity of alkaline neutral-red solutions arranged around a water-filled glass bottle, with light from a tungsten lamp. This light-effect was very distinct in 1963, but was absent or barely evident from 1964 to 1966. However, again it became demonstrable at the end of January 1967, and has continued so up to the present (May 1967), though becoming less and less distinct. At the same time, corresponding changes were found with the reversal phenomenon of X-agent. That is, the reversal of the action of the X-agent on alkaline neutral-red solutions was hardly observable during the period from 1964 to 1966, and not as distinct or constant as in 1963; it again became demonstrable at the end of January 1967. It was reported earlier that various phenomena concerning X-agent tended to become obscure around 1965. The two phenomena described are said to have been most profoundly influenced by some factor prevailing during the 1965 period. Although the phenomena have again become observable recently, some previous features have not yet been completely manifested again. The suggested cause of this change is considered to be related to diminished solar activity. The change was demonstrable in different locations scores of kilometers distant from each other, but the degree of the change was not the same as such distances. The light-effect was observable, though slightly, and with alkaline thymol-blue solutions even in 1966 when the alkaline neutral-red solutions failed to show the effect. (BBB)

49249 INVESTIGATIONS ON THE NUCLEIC ACIDS CONTENT IN THE BRAIN OF NEONATAL RAT X-RAY IRRADIATED AT DIFFERENT PERIODS OF FETAL LIFE. II. BIOCHEMICAL DNA AND RNA ASSAY IN THE NERVOUS TISSUE. Mularek, Olga (Medical Academy, Poznan, Poland). Exp. Pathol., 2: 128-33 (1968).

Studies were carried out on rats x irradiated at 6.5, 9.5, and 18.5 days of pregnancy with 250-R doses. In another experiment the animals were subjected to irradiation on the 9.5 day of pregnancy with a 150-R dose. The dry mass and the water content per 100 g of fresh tissue for the group irradiated at 6.5 days of pregnancy was compared with the 250-R dose and they did not differ

from results obtained for the control group. The brains of the animals irradiated on the 9.5 day of prenatal life with 150 R, and also of those irradiated on the 18.5 day with 250 R, showed decreased dry mass and correspondingly increased water content. A statistically significant decrease of the net DNA and RNA content, calculated per weight unit of the fresh brain and for the total brain weight, was seen in animals irradiated at the 9.5 and 18.5 days of pregnancy. The decrease of RNA content was more marked than that of DNA. If the estimations were made with respect to tissue dry mass, the effects were not significant. The nucleic acid content in the brain of neonatal rats irradiated on the 6.5 day of prenatal life did not differ from the value for the control group. Loss of neural cells as a result of irradiation during the period of nerve cell development appeared to explain the observed changes. (BBB)

49250 TRANSPORT FUNCTIONS OF THE ENDOPLASMIC RETICULUM OF SUBLETHALLY IRRADIATED CHICKEN HEART MYOBLASTS. Schaefer, Dieter (Univ., Bonn. Kernforschungsanlage, Juelich, Ger.). Z. Zellforsch. Mikroskop. Anat., 71: 562-73(1966). (In German).

By means of phase contrast microscopy vacuoles were observed in the cytoplasm of cultured chicken myoblasts after sublethal irradiation of 1,200 R x rays. The vacuoles migrated within the cytoplasm and fused, thus forming large vesicles. They were transported to the surface of the cell and later they were excreted. In living cells the vacuoles moved in certain light tracks as observed under the phase contrast microscope. Electron micrographs showed that the vacuoles produced by x rays possess no contrast and only occur in the perinuclear space and in channels of the endoplasmic reticulum (ER) that are vesicle-like enlarged. The light tracks of the cytoplasm described represent parts of the ER, in which the movement of the vacuoles can be observed. The studies showed that the ER of irradiated myoblasts have the function of transport. The contents of the vacuoles are transported to the periphery of the cell using the space of the ER as pathway. In the surface region the ER comes into contact with the cell membrane, which shortly opens for removing the contents of the vacuoles out of the ER. (auth)

49251 THE EFFECTS OF IONIZING RADIATION ON NUCLEIC ACIDS OF BACTERIOPHAGES AND BACTERIAL CELLS. Ginoza, William (Pennsylvania State Univ., University Park). Annu. Rev. Microbiol., 21: 325-63(1967).

The nature of the radiochemical lesions induced by ionizing radiations in the nucleic acids of viruses and bacteria are reviewed and evidence for the relation between these lesions and the loss of viability of these organisms is discussed. The topics discussed included: electron spin resonance analysis of radiation damage to nucleic acids, showing the yield, nature, and sites of free radicals, the inter- and intramolecular energy transfers; radiochemistry of nucleic acids; radiobiology of viruses, with consideration of the target theory analysis of single-stranded nucleic acid viruses and double-stranded DNA viruses; effects of ionizing radiation on nucleic acid components of the bacterial cell, including the radiosensitivities of template functions of DNA, messenger RNA functions, ribosomes, and transfer RNA; and radiobiology of bacteria. Also discussed was the implication of DNA as the primary target in the cell; the composition, degradation, genetic and molecular basis for DNA repair after irradiation. Micrococcus radiodurans, an organism resistant to both uv and ionizing radiations, was also discussed. (268 references.) (BBB)

49252 EFFECT OF ULTRAVIOLET IRRADIATION ON THE EPIDERMIS. II. CHANGES IN MUCOPOLYSACCHARIDES. Szabo, E.; Horkay, I. (Univ. Medical School, Debrecen, Hungary). Acta Morphol. Acad. Sci. Hung., 15: 383-9(1967).

Human skin specimens obtained 4 to 6 hr after uv irradiation with 4 erythema doses were studied histochemically. As compared to normal skin, the cytoplasm of the upper cells of the stratum spinosum of the irradiated skin contained large amounts of coarse PAS-positive granules. Since the granules disappeared after diastase treatment, they corresponded to glycogen-like substances. The nuclei of more deeply situated prickle cells and basal cells showed positive Hale reactions. Intensive Hale reaction granulation was observed in the stratum granulosum. A comparison of 1-, 3-, and 5-day postirradiation specimens showed that the basement membrane gradually became wider and showed intensive diastase-resistant PAS positivity. Glycogen granules were not observed. The amount of glycogen gradually decreased in the stratum spinosum, and it disappeared by the 5th day. In place of the stratum granulosum a parakeratotic band developed that was characterized by a homogeneous, diastase-resistant and PAS-positive basal structure containing Hale-positive nuclear debris. After 12 days the width and PAS reactivity of the basal membrane increased. The number of mitoses decreased and some nuclei again became Hale positive. It was concluded that high doses of uv light caused glycogen accumulation in the stratum spinosum and that the glycogen disappeared when parakeratosis developed. Multiple minimal doses of uv light caused no glycogen accumulation in the epidermis. Parallel with the increased mitosis in the basal layer, the basement membrane became thick and stained intensively with PAS. Ultraviolet radiation absorbed in the stratum spinosum contributed to the production of parakeratosis and that reaching the basal layer increased the rate of cell division. (BBB)

49253 MORPHOLOGICAL AND BIOCHEMICAL CHANGES IN EPIDERMAL NUCLEI AND NUCLEIC ACID FOLLOWING ULTRAVIOLET EXPOSURE. Ogura, R.; Freeman, R. G.; Knox, J. M. (Baylor Univ., Houston, Tex.). Dermatologica, 136: 11-17(1968).

A micro-analytical technique was used to detect the alterations in nucleic acids of epidermis in rats exposed to uv light and to determine if there was a relation between these alterations and the morphological changes in epidermal nuclei. Chloroquine was fed to some animals to see how it would affect these alterations, since it was beneficial in the treatment of certain photosensitivity diseases. Young male albino rats were irradiated for 2 min daily at a distance of 50 cm from 2 hot quartz broad-spectrum uv lamps (output 3.3×10^3 erg/cm^2 sec). After two months, the response was minimal so exposure time was increased to three minutes daily. Total exposure was 8.5×10^7 erg/cm^2. Rats were killed at intervals during a 7-month period and their skin examined. A micro method using uv absorption for determination of DNA and RNA in epidermis was described. The average content of normal rat epidermis estimated by this method was 20.2 μg RNA and 12.6 μg DNA per 1 mg of dried epidermis. The DNA content decreased significantly, but no significant change was detected in the RNA content. The diameters of nuclei and the DNA content decreased; however, the number of nuclei remained about the same. Oral administration of chloroquine seemed to inhibit partially the alterations in nuclei, although statistically significant differences were not observed. (BBB)

49254 PROLIFERATION AND DIFFERENTIATION OF AUTOLOGIC AND ALLOGENIC STEM CELLS IN SUPRALETHALLY X-IRRADIATED DOGS. Chertkov, I. L. (Central Inst. of Haematology and Blood Transfusion, Moscow). pp 84-5 of Effects of Ionizing Radiations on the Haematopoietic Tissue. Vienna, International Atomic Energy Agency, 1967.

See STI/PUB-134.

Allogenic bone marrow after transplantation into dogs irradiated with 1000 R x rays differentiated in the normal way only for 3 to 4 days, afterwards transforming into lymphoid cells. This transformation was due to the antigen stimulus of the host on the grafted stem cells. The lymphoid cells, obtained from the host's blood on the 7 to 8th day after grafting, showed specific immune activity. Within a short duration of the immune response, immunoblasts and immunocytes underwent degenerative changes; they destroyed mitochondria, formed autophagic vacuoles and, finally, lysed. These changes were suggested to be the result of overloading of immune cells with antigen. Preliminary sensitization of the donor with prospective host's haemopoietic tissue did not hasten the immune transformation of haemopoiesis. Injections of bacterial pyrogen, cortisone, or 6-mercaptopurine into recipients, as well as incubation of bone marrow at 37°C for 2 hr, did not prevent the immune transformation. Preliminary thymectomy of the prospective recipients prevented in some of the cases immune transformation of the bone-marrow graft. The delay of allogenic bone-marrow transplantation for 5 to 6 days prevented the immune transformation in some dogs (x irradiated with 1000 R, but not with 1200 R). Transplantation of autologic bone marrow or shielding of the legs during irradiation was accompanied by good restoration of normal haemopoiesis without lymphoid transformation. (auth)

49255 URANYL ACETATE, A STAIN AND A FIXATIVE. Terzakis, John A. (Francis Delafield Hospital, New York). J. Ultrastruct. Res., 22: 168-84(Jan. 1968).

The tissue localization of uranyl ion was examined by electron microscopy in the avian malarial parasite Plasmodium gallinaceum in Aedes aegypti mosquitoes. The use of dilute aqueous uranyl acetate after double fixation with either citrate- or phosphate-buffered glutaraldehyde and OsO_4 gave the best preservation of membranous structures. Aqueous uranyl acetate, used after double fixation and before dehydration, not only stained the membranes, but markedly improved their preservation as evidenced by their continuity and trilaminar configuration. The mechanism of tissue localization of uranyl ion is discussed. Some authors have proposed that uranyl acetate or lanthanum nitrate acted to stabilize DNA. It was shown that treatment of DNA preparations with uranyl acetate before alcohol prevented ex-

traction of DNA from its protein shell, also indicating that uranyl acetate stabilized the DNA. (BBB)

49256 UNITED STATES BERYLLIUM CASE REGISTRY (1952–1966): REVIEW OF ITS METHODS AND UTILITY. Hardy, H. L.; Rabe, E. W.; Lorch, S. J. Occup. Med., 9: 271-6(June 1967).

A registry for all diseases connected with beryllium exposure is described, which is particularly interesting for diagnosis purposes and research into beryllium's carcinogenic action in man. Difficulties met with, methods applied, limitations, and advantages of this registry are given. Data processing by manually punched cards and computer is discussed. This system, despite problems it poses, has already enabled good use to be made of the 760 cases registered so far: data on the chronic stage following the acute stage; correlation of exposure intensity and the disease; of latency period and extent of disease; efficacy of occupational hygiene; pathological changes (no cancer so far, rare tuberculosis cases); mortality; reduced mortality with steroid treatment; complications. There are numerous tables and graphs. (Occup. Safety and Health Abstr.) (CIS)

49257 THE METHOD OF RADIOACTIVE TONING (ESPECIALLY FOR ^{32}P) AND ITS APPLICATION IN MICRO-AUTORADIOGRAPHY FOR COMPARATIVE RESOLUTION EXAMINATIONS. Bleecken, S. (Institut fuer Mikrobiologie und experimentelle Therapie, Jena, Ger.). Atompraxis, 14: 349-52(Aug. 1968). (In German).

Test images prepared by radioactive toning of the silver in minute photographic gratings are qualified for examination of resolution and contrast transfer in autoradiography. Various possibilities of radioactive toning are discussed and multi-step procedures suitable for ^{3}H, ^{14}C, ^{32}P, and other radioactive nuclides are described. By means of ^{125}I-, ^{131}I-, and ^{32}P-toned test gratings the influence of beta energy on resolution of Kodak AR 10 and AR 50 stripping film is examined. (auth)

49258 EFFECT OF ANTIHISTAMINIC PREPARATIONS AND TRIIOTRAST ON THE PERMEABILITY OF ^{24}Na FROM THE BLOOD INTO TISSUES. Sergeev, P. V.; Gubarev, E. A. (Pirogov Medical Inst., Moscow). Patol. Fiziol. Eksp. Ter., 9: 53-6 (Jan.-Feb. 1965). (In Russian).

Experiments were conducted on cats (wt 3.4 to 4.8 Kg) anesthetized with urethane. The blood flow was measured with a polyethylene tube (1.5 to 2 mm diameter) inserted through a cannula in the central and peripheral segments of the carotid artery. Counts of ^{24}Na were recorded every 30 sec. One ml of physiological solution containing 1 μCi/ml $^{24}NaCl$ was quickly injected into the femoral vein. The results indicated that intravenous administration of 1 ml/Kg of Triiotrast, an x-ray contrast preparation, considerably accelerated the vascular permeability of ^{24}Na from the blood into the extracellular fluid. At 10 and 30 min following the injection of Triiotrast, the disappearance of ^{24}Na from the blood decreased by nearly $\frac{1}{3}$ from the initial rate. After 60 min, a tendency was noted toward restoration of normal permeability of ^{24}Na from the bloodstream. Antihistaminic preparations (Diprazin and Dimedrol) injected intraperitoneally in doses of 5 mg/Kg reduced the action of Triiotrast on ^{24}Na exit from the circulation. (BBB)

49259 ACTION OF X AND γ RADIATION ON SOME ASPECTS OF METABOLISM OF NUCLEIC ACIDS. Pasquinelli, V.; Sassi, P.; Barbiroli, B.; Moruzzi, M. S. (Univ., Bologna). Radiobiol. Radioter. Fis. Med., 22: 376-87(Nov.-Dec. 1967). (In Italian).

The comparative effects of x and γ rays at various doses on some aspects of the metabolism of nucleic acids in rat liver 48 hours after irradiation were studied. The nucleic acids showed an increase for each of the administered doses, while acid-soluble free nucleotids, both purinic and pyrimidinic ones, showed a constant decrease. The enzymatic activities studied were in accord with these results. (auth)

48260 SOME COMMENTS ON BERYLLIUM GRANULOMA. Folesky, H. Berufsdermatosen, 15: No. 4, 93-103(Apr. 1967). (In German).

A case of beryllium granuloma is described involving a patient who cut the ring finger of his right hand on a broken fluorescent tube. Patch tests with beryllium sulphate and beryllium nitrate produced positive results. Treatment with prednisone produced a temporary regression, that ceased however, as soon as the treatment was stopped. The granuloma was then removed surgically. Patch tests undertaken five years later again proved positive. The author suggests that repeated tests with beryllium salts may lead to sensitization. He regards removal of granuloma by incision as preferable to treatment with corticosteroids. (Occup. Safety and Health Abstr.)

49261 ROLE OF INTERMOLECULAR REACTIONS IN THE FORMATION OF SECONDARY RADICALS IN PROTEINS IRRADIATED IN THE DRY STATE. Copeland, Edmund S.; Sanner, Rore; Pihl, Alexander (Norwegian Radium Hospital, Oslo). Radiat. Res., 35: 437-50(1968).

The mechanism of formation of secondary radicals in x-irradiated proteins was studied by electron spin resonance spectroscopy. Ribonuclease, thiolated gelatin, and egg albumin were irradiated at 77°K, alone, as well as in the presence of oxygen or adenine. The spectra were recorded immediately after irradiation and after heat-treatment to predetermined temperatures. The presence of high concentrations of adenine during irradiation prevented the formation of sulfur radicals in ribonuclease and doublet-type radicals in thiolated gelatin. The presence of oxygen did not alter the radical yield or the qualitative spectra observed at 77°K. Oxygen, like adenine, prevented the formation of the typical secondary radicals on heat-treatment. Qualitative spectra were observed which were ascribed to transient HO_2 radicals, presumed to be formed by decomposition of organic peroxide radicals. The results were interpreted to mean that in proteins irradiated in vacuum the secondary radicals formed on heat-treatment arose largely by intermolecular reactions mediated by diffusible radicals, primarily H· atoms, that could be scavenged by a second component like adenine. (auth)

49262 ABSORPTION BY THE RAT OF ALGINATE LABELED WITH ^{14}C. Humphreys, E. R.; Triffitt, J. T. (Medical Research Council, Harwell, Eng.). Nature (London), 219: 1172-3(Sept. 14, 1968).

Experiments are described showing that there is no significant absorption of alginate by rats from a diet in which the alginate is present in a proportion used to inhibit Sr absorption (for example from high levels of ^{90}Sr in food). (UK)

49263 RECOVERY OF NORMAL CAPACITY TO FORM RNA IN ACRIFLAVINE BY BACTERIA DAMAGED BY ULTRAVIOLET LIGHT. Doudney, C. O. (Albert Einstein Medical Center, Philadelphia). Nature (London), 219: 1161-2(Sept. 14, 1968).

Acriflavine, in a concentration which has no effect on unirradiated bacteria, was found to limit the increase of RNA in a culture of E. coli B/r exposed to UV light. Studies were described indicating that this dyestuff inhibits formation of DNA in UV damaged bacteria through interaction with a non-photoreversible lesion, presumably not a dimer (Doudney, Photochem. Photobiol. 6: 651 (1967)), and it was supposed that such damage could also be responsible for the effect of the dye on RNA formation (Doudney, Nature 205: 528(1966)). In the present studies it was sought to determine the nature of the photochemical lesion responsible for the effect of the dye on RNA formation in UV damaged bacteria by investigating the photoreversibility of the effects in strains of E. coli with and without capacity for photo-enzyme splitting of the pyrimidine dimer. It was also sought to show that recovery of RNA formation through dark repair processes is complete by studying the recovery of the normal capacity to produce 30S and 50S ribosome in the presence of the dye. The data suggest that the pyrimidine dimers left in the DNA because of the action of the dye interfere with RNA formation and that the elimination of dimers by dark repair mechanisms results in normal RNA synthesis and ribosome formation even in the presence of the dye. (UK)

49264 ROLE OF PROLIFERATION IN DELAYED HYPERSENSITIVITY. Feldman, Joseph D. (Scripps Clinic and Research Foundation, La Jolla, Calif.). J. Immunol., 101: 563-71 (Sept. 1968).

Heavily irradiated nondividing lymphoid cells from immune donor Lewis rats were capable of transferring delayed hypersensitivity (DH) to neutral recipients. Serial transfer of DH beyond a second passage failed and was only occasionally achieved in secondary recipients. Cells from immune donors could not be boosted by antigen or PPD (purified protein derivative of Mycobacterium tuberculosis) to enhance serial transfer or the severity of DH. These results indicated that cellular proliferation was not a necessary part of the expression of DH. Lymphoid cells acquired immunologic competence to transfer DH only after continuous in vivo incubation with antigen and only after the donors exhibited positive skin reactions. (auth)

49265 ACTIVITY OF HEXOKINASE IN THE BRAIN AND MUSCLE OF MICE DURING FRACTIONATED X IRRADIATION AT A DOSE OF 760 r. Kukulyanskaya, M. F. Vestsi Akad. Nauk BSSR, Ser. Biyal. Navuk, No. 2, 115-16(1968). (In Russian).

Pubescent white male mice were x-irradiated fractionally with the RUM-11 device. The single dose was 40 R and the total dose was 760 R. The activity of the hexokinase in homogenates obtained from the large hemisphere of the brain was reliably in-

creased 15, 30, 60, and 90 days after irradiation. In the muscle the hexokinase activity was increased on the 15th and 30th day, and then returned to the original level. Dose fractionation resulted in an increase in the glucose phosphorylation capacity of brain and muscle homogenates. (tr-auth)

49266 STUDIES OF THE ROLE OF THE COAT PROTEIN IN THE U.V. PHOTOINACTIVATION OF U(1) AND U(2) STRAINS OF TMV. Streeter, D. G.; Gordon, M. P. (Univ. of Washington, Seattle). Photochem. Photobiol., 8: 81-92(Aug. 1968).

Two properties of the uv inactivation process in the uv-sensitive U(2) strain of tobacco mosaic virus have been investigated: (1) The increased binding of protein to RNA induced by irradiation of the virus at 254 nm; (2) The action spectrum for uv inactivation of U(2) between 250 nm and 285 nm. The extent of the uv induced binding of protein to RNA is similar to that previously found in the resistant U(1) strain, thereby eliminating the possibility that the capacity for this binding phenomenon bears any correlation to the difference in uv sensitivities of these two viruses at 254 nm. The results indicate that the radiation induced interaction of protein and RNA in U(1) and U(2) are probably similar. The action spectrum for U(2) resembles the absorption spectrum of the RNA between 250 nm and 285 nm implicating the RNA as the primary absorber leading to inactivation of the virus in this region of the spectrum. Quantum yields calculated for U(2) virus and free TMV-RNA irradiated at 254 nm reveal that the irradiated free RNA may be as much as 1 to 4 times more sensitive to inactivation at this wavelength than RNA in the intact virus. It is concluded that the coat protein of U(2) probably offers some protection to the enclosed RNA against uv damage at 254 nm, therefore, the difference in uv sensitivity between U(1) and U(2) TMV at this wavelength is a consequence of a difference in the degree of protection offered by the respective coat proteins to the enclosed RNA. (auth)

49267 MITOCHONDRIAL RESISTANCE TO MASSIVE IRRADIATION IN VIVO. V. REPAIR AND THE REPAIR OVERSHOOT. Romani, R. J.; Yu, Ida K. (Univ. of California, Davis). Arch. Biochem. Biophys., 127: Nos. 1-3, 283-7(Sept. 20, 1968).

An immediate mitochondrial response to injury is apparent when megarad doses of γ radiation are absorbed by quiescent fruit cells. Mitochondrial oxidative activity, ADP/O, and respiratory control were used as indices of radiation injury and repair. The time-course of recovery and the response to split radiation doses reveal an overcompensation of the initial injury. This is interpreted to result from an overshoot either in repair processes or in de novo synthesis of mitochondria. (auth)

49268 DEGRADATION OF THE DNA OF ESCHERICHIA COLI K12 REC$^-$ (JC1569b) AFTER IRRADIATION WITH ULTRAVIOLET LIGHT. Horii, Z. I.; Suzuki, K. (National Inst. of Radiological Sciences, Chiba, Japan). Photochem. Photobiol., 8: 93-105(Aug. 1968).

Degradation of the DNA of a rec$^-$ mutant of Escherichia coli K12 (JC1569 b) induced by uv light was investigated. The rate of degradation was much larger by growing bacteria than by stationary cells. When growing bacteria were starved for amino acids, their DNA became resistant to irradiation. The mode of uv-induced degradation was investigated by comparing the time course of release from the acid-insoluble fraction of the label for two growing cultures; the one was pulse-labeled with ^{3}H-thymidine and the other was pulse-labeled and chased thereafter for 12 min. It was found that the label incorporated into the former culture begins to be lost from the acid-insoluble fraction prior to the loss of the label incorporated into the latter culture. It was concluded that breakdown of the replicating point precedes degradation of the bulk of the DNA. This result suggested that the replicating point is a sensitive site to irradiation and the uv-induced degradation of DNA seemed to be influenced by the state of chromosome at the time of irradiation. Experiments of centrifugation of lysed spheroplasts of bacteria uniformly labeled with ^{3}H-thymidine in alkaline sucrose demonstrated that DNA of low molecular weight appeared after irradiation with only 5 ergs/mm^2, and that the molecular weight could not be restored by post-irradiation incubation. Considering these results, an hypothesis is proposed concerning the initiation of induced degradation of the DNA of the rec$^-$ mutant. (auth)

49269 IRREGULARITY OF RADIOIODINE DISTRIBUTION IN THE THYROID GLAND. Zaichik, V. E.; Ryabukhin, Yu. S.; Tkachev, A. V. (Inst. of Medical Radiology, Erevan). Med. Radiol., 13: No. 4, 59-62(1968). (In Russian).

The article deals with theoretical elaborations of the problem of irregularity of distribution of incorporated isotopes. The degree of diverse distribution of iodine-131 in the thyroid parenchyma of intact puppies was studied against the background of administration of somatotropic hormone. The method of quantitative autoradiography was used with the use of a radioactive wedge as a means of a standard source. Contact autograms of thyroid sections and standard wedges were obtained on "MP" plates. Photometry was conducted on a microphotometer. The size of the photometric area of the autogram comprised 4250 m^2. There were found marked irregularities of radioiodine distribution in the thyroid tissue of puppies. Thus, for intact puppies the fluctuations comprised one amplitude, whereas in the instance of administration of the somatotropic hormone—up to two amplitudes. The data testify to the expediency of further study of the irregularity of radioiodine distribution in the thyroid glands in connection with the possible radiation injury of normal thyroid tissue in diagnostic and therapeutic measures. (TSS)

49270 DETERMINATION OF THE CONTENT OF STABLE IODINE IN THE THYROID GLAND BY THE METHOD OF ACTIVATION OF SUPERCADMIUM NEUTRONS WITHOUT DESTRUCTION OF THE SAMPLE. Ryabukhin, Yu. S.; Mel'nik, A. D.; Kharlampovich, S. I.; Obaturov, G. M.; Kozlov, V. A. (Inst. of Medical Radiology, Erevan). Med. Radiol., 13: No. 4, 54-8(1968). (In Russian).

Neutron activation analysis for determining the content of stable iodine in the thyroid gland of rats is described. The samples were irradiated with supercadmium neutrons, enabling analysis without destruction and on beta-counters, i.e., without the use of gamma-spectrometric measurements or radiochemical methods. The source of neutrons was the BP-5 reactor on fast neutrons. (auth)

49271 INFLUENCE OF GAMMA-RADIATION ON THE ULTRASTRUCTURE OF ADENOHYPOPHYSIS. Dedov, I. I.; Zenzerov, V. S. Med. Radiol., 13: No. 4, 9-14(1968). (In Russian).

Histological and submicroscopic changes were studied in the glandular cells of the anterior lobe of the hypophysis of rats of Wistar line, γ irradiated at 900 R. Five types of hormone-forming cells were differentiated. These vary by their ultrastructural organization and by peculiarities of the fine structure of secretory granules. Basophils are more radiosensitive. In the latent period of radiation sickness early degranulation is noted. In the terminal period there occurs a complete liberation of the cell from secretory material. Oxyphils are more radioresistant. Peculiar radiation indicators are mitochondria which are the first to react to destructive changes. Profound destructive processes occurring in the hypophyseal cells in the terminal stage of radiation sickness are not attended by accumulation and alteration of the enzymatic activity of lysosomes. (auth)

49272 NEUROENDOCRINE REACTIONS AND THE RADIATION-INDUCED VARIATIONS IN RAT INTESTINAL ALKALINE RIBONUCLEASE LEVELS. Gresham, P. A.; Pover, W. F. R. (Univ. of Birmingham, Eng.). Radiat. Res., 34: 256-64(1968).

The alkaline RNAase level of mucosal scrapings from rat small intestine was increased after 700 R of whole-body x irradiation, when expressed as total intestinal content or relative to DNA or protein levels; this increase occurred as early as 3 hours after irradiation. Increases also occurred after local irradiation of the head. Both the inhibition of neuroendocrine reactions in mature rats by the administration of drugs, and the use of infant rats in which these reactions do not occur, suppressed the alkaline RNAse increase after irradiation, thus indicating that neuroendocrine reactions may be the cause of the enzyme increase. The application of ACTH, hydrocortisone, or general stressing agents did not produce any increase in the enzyme level, but the radiomimetic chemicals Chlorambucil and Myleran did cause increases similar to those induced by radiation. (auth)

49273 ULTRASTRUCTURAL LOCALIZATION OF ACID MUCOPOLYSACCHARIDES IN THE INTESTINE AFTER IRRADIATION. Berlin, Jerry D. (Battelle Memorial Inst., Richland, Wash.). Radiat. Res., 34: 347-56(1968). (BNWL-SA-1359).

Subcellular localization of acid mucopolysaccharide (AMPS) was only slightly discernible in normal rat intestinal absorptive cells. Immediately after 1000 R of whole-body x irradiation the Golgi complex of the absorptive cell possessed AMPS, but the thin enteric surface coat did not. At 5 hours after exposure the Golgi complex was lightly stained and a thick, AMPS-rich surface coat was present. These observations suggest that the Golgi complex participates in the final synthesis of AMPS that becomes a component of the enteric surface coat. (auth)

49274 EFFECT OF X-IRRADIATION ON THE LACTATE DEHYDROGENASE LEVEL IN PLASMA AND IN VARIOUS ORGANS OF MICE. Hori, Yasuharu; Takamori, Yasuhiko; Nishio, Kazuo (Radiation Center of Osaka Prefecture, Sakai, Japan). Radiat. Res., 34: 411-20(1968).

Male mice of the RF strain, 6 to 8 weeks old, were given a

single exposure to whole-body x irradiation. Lactate dehydrogenase (LDH) activity in the plasma and in various organs was determined at various time intervals after exposure. The plasma LDH level was increased within several hours after exposure to 600 R. The extent of the elevation of plasma LDH level was proportional to irradiation exposure in the range below about 900 R. Thymus and spleen, which are known to be radiosensitive, exhibited a marked loss of LDH by exposure to 600 R, whereas liver, kidney, and testis, which are radioresistant, showed no significant changes between control and irradiated mice. In the split-dose study, in which mice were given a second exposure to 600 R at 24 hours after a first 600-R exposure, no noticeable changes in plasma LDH levels were found after the second exposure. It was concluded that the radiation-induced elevation of plasma LDH level may be attributed mainly to the release of the enzymes from radiosensitive cells. (auth)

49275 MOLECULAR AGGREGATION AND SEROLOGICAL SPECIFICITY OF HUMAN SERUM ALBUMIN IRRADIATED IN SOLUTION. Hay, M.; Zakrzewski, K. (Inst. of Nuclear Research, Warsaw). Radiat. Res., 34: 396-410(1968).

Human serum albumin and human serum albumin complexed with sodium caprylate in aqueous solutions were exposed to 125 to 4500 kR of ^{60}Co radiation. The properties of the irradiated solutions were investigated by Sephadex gel filtration, starch gel electrophoresis, paper strip electrophoresis, and quantitative microcomplement fixation. Sephadex G-200 filtration showed dependence between the increase of the dose and the fraction of aggregated albumin molecules. Electrophoretic analysis indicated that the charge of the irradiated molecules was not significantly altered. Sodium caprylate in the amount of only 3 moles per mole of albumin exhibited a marked protective effect. The protective effect increased with increasing caprylate-to-protein ratio. The serological activity of irradiated albumin solutions, measured by complement fixation assay, showed a dose-dependent decrease. This decrease was quantitatively accounted for in terms of two protein fractions: the aggregated protein, which exhibited an approximately tenfold reduction in complement-fixing ability; and the protein of the native molecular size, which was undistinguishable from nonirradiated albumin in complement fixation tests. No differences in serological activity have been observed among the aggregated fractions formed in solutions exposed to different doses. The reported experiments indicate that the loss of serological activity of irradiated albumin may be due to the formation of aggregates. (auth)

49276 REPAIR OF RADIATION DAMAGE TO ERYTHROCYTE MEMBRANES: THE REDUCTION OF RADIATION-INDUCED DISULFIDE GROUPS. Sutherland, Robert M.; Pihl, Alexander (Norsk Hydro's Inst. for Cancer Research, Oslo). Radiat. Res., 34: 300-14(1968).

Radiation damage and recovery of sulfhydryl groups of erythrocyte membranes have been studied by irradiating suspensions of human erythrocytes or isolated ghosts with x rays and measuring the remaining membrane sulfhydryl groups with 5'5-dithiobis-(2-nitrobenzoic acid). Decomposition of the nonexponential dose-response curves indicated that the membrane sulfhydryl groups consist of two classes with widely different radiosensitivity, the most radiosensitive fraction constituting about 10% of the total number of –SH groups. Factors expected to influence the structure of the membrane altered the percentage of radiosensitive –SH groups. The loss of –SH groups was greater when isolated ghosts were irradiated than when intact cells were exposed. Disulfide formation, as revealed by sodium borohydride reduction, accounted for the major part of the –SH lost on irradiation. In erythrocytes incubated for 1 hour at 37°C in the presence of glucose after exposure, about 60% of the –SH lost on irradiation reappeared. No recovery of –SH groups occurred either at low temperature, in the absence of glucose, or in isolated ghosts. Direct measurements of the membrane disulfide content indicated that the reappearance of –SH groups after exposure was due to reduction of radiation-induced disulfides. The data presented demonstrate that human erythrocytes possess a mechanism permitting them to reduce membrane disulfides under conditions of active metabolism. This mechanism may explain the repair of permeability observed under similar conditions by previous authors. (auth)

49277 THE ACTIVITY OF α-AMYLASE AND α-GLUCAN PHOSPHORYLASE IN THE LIVER UNDER CONDITIONS OF COMBINED ACTION OF X RAYS AND EMBITOL. Borisova, O. S. Ukr. Biokhim. Zh., 40: 292-6(1968). (In Russian).

In experiments on rabbits the activities of α-amylase and α-glucanphosphorylase of the liver and blood serum were investigated under conditions of separate and combined action of x rays (900 rad) and administered embitol (12.4 mg/kg; LD-50). Irradiation caused an increase in the activity of amylase of the liver. The activity of α-glucanphosphorylase was inhibited during the first to third day and then on the seventh to tenth day it increased. Embitol affected the activity of amylase of tissues to a lesser extent than radiation; the activity of α-glucanphosphorylase of the liver under these conditions was noticeably inhibited. A combined effect of ionizing radiation and embitol caused a definite inhibition in the activity of α-glucanphosphorylase of the liver. A similar effect was also caused only by embitol; however, its influence was significantly weaker. (auth)

49278 TOTAL RATE OF BODY TURNOVER OF ^{75}Se IN RATS. Yousef, M. K.; Coffman, W. J.; Johnson, H. D. (Univ. of Missouri, Columbia). Nature (London), 219: 1173-4(Sept. 14, 1968).

The biological significance of Se as an essential micronutrient and toxic agent gives rise to a great interest in studies of its metabolism. The use of ^{75}Se offers two methods for studying the metabolism: direct measurement of radiation from an animal, and measurement of the difference between injected dose and cumulative activity in excreta; the latter method proves less satisfactory. Studies are described on the total turnover rate of ^{75}Se in rats by total body γ-counting, and also on its excretion in faeces and urine. The selenium was in the form $H_2{}^{75}SeO_3$. The studies indicated urine and faecal excretion to be about 28% of the dose. It was surprising that the ^{75}Se was excreted in approximately equal amounts in faeces and urine. The pattern of excretion changed from a very rapid rate during the first 4 days to a slower rate during the following 11 days. (UK)

49279 ACTIVATION OF A CYTOSTATIC COMPOUND (CYCLOPHOSPHAMIDE–ENDOXAN) BY IONIZING RADIATION. PART I. ACTIVATION OF ENDOXAN BY IRRADIATION IN AQUEOUS SOLUTION. Tachiiri, Hiromu; Gamo, Tetsuo; Yoshimura, Shosuke; Shigematsu, Yasushi; Hara, Kazuo; Yoshii, Giichi; Iwo, Kazuhiro (Osaka Univ. Hospital. Osaka Univ.). Strahlentherapie, 136: No. 1, 76-81(July 1968). (In German).

An aqueous solution of the cytostatic compound endoxan (EX) irradiated with high doses of γ radiation was activated and had a pronounced cytostatic influence on HeLa cells and E. coli. This influence was due to the activation by irradiation of the solution. The more dilute the solution, the more pronounced the activation. Crystals of EX however, were only slightly influenced by doses of 10^5 R. A quantitative indirect effect could be demonstrated by activation of EX through irradiated solvent. It was concluded that the activation occurs principally through an indirect radiation effect. The activated substance could be isolated from the irradiated EX. The substance is, however, not a simple hydrolysis product, its nature is up to now unknown. From the results of experiments with E. coli in the mitosis-less phase, it was concluded that there is no simple hypothesis for the cytostatic studies with EX concerning the mitotic blocking of the cells. The buffer-solution exhibited also a cytostatic activity during a certain time, but only after irradiation with high doses. (auth)

49280 INVESTIGATION ON COMBINATION INJURIES. PART 9. ENZYMATIC INVESTIGATION OF TRYPTOPHAN METABOLISM OF MICE, WHICH WERE BURDENED BY A COMBINATION OF WHOLE-BODY IRRADIATION AND OPEN SKIN WOUNDS. Streffer, Christian; Messerschmidt, Otfried (Univ., Freiburg i. B.). Strahlentherapie, 136: No. 1, 88-92(July 1968). (In German).

The activity of kynureninase and 5-hydroxytryptophan decarboxylase was studied in the liver of mice during the fourteen days following whole-body x irradiation with 510 R, after a skin wound, and after combination of both trauma. The kyureninase activity was lowered after irradiation but elevated after the skin wound. When the surgery was done two days after 510 R, so significant changes of the enzyme value were observed. The activity of the decarboxylase was depressed after irradiation alone, and after combined trauma was even lower. Skin wounds seemed not to influence this enzyme system. (auth)

49281 EFFECT OF X-RAYS ON THE PROTEOLYTIC ENZYMES OF GRANULOCYTES AND ON PHAGOCYTOSIS INDEX IN GUINEA-PIGS. Prokopowicz, J.; Rejniak, L. (Medical Academy, Bialystok, Poland). Experientia, 24: 783-4(Aug. 15, 1968).

Guinea pigs were x-irradiated at doses of 350 R. The phagocytosis index was determined from peritoneal exudate induced by glycogen injection. Leukocytes in exudates were studied for activity of enzymes. Irradiation induced a significant decrease in activity of all fibrinolytic and proteolytic enzymes and phagocytosis decreased slightly. (C.O.)

Ecology

Refer also to abstracts 49181 and 49355.

49282 (PRNC–119) THE RAIN FOREST PROJECT ANNUAL REPORT. Kline, Jerry R.; Jordan, Carl F.; Drewry, George E. (Puerto Rico Nuclear Center, Rio Piedras). June 1, 1968. 147p. Dep. CFSTI.

The Rain Forest Project is a series of studies on one small area of montane rain forest 1500 feet up the side of El Yunque mountain in eastern Puerto Rico. It has three objectives: to study the effects of gamma radiation on the tropical ecosystem; to study mineral cycling and dispersion in the system; and to study the basic biological functions of this ecosystem such as respiration, transpiration, and photosynthesis to better understand phenomena related to the first two objectives. The project is in its fifth year. A section of the forest was irradiated and many follow-up studies have been completed. Present effort is being directed to long term studies on recovery and succession of vegetation in the irradiated area, and to detailed investigations of mineral cycling and distribution in the tropical ecosystem. Sections on recovery of the irradiated area, light measurements in the forest, water and nutrient cycling in the forest, and radionuclide behaviour in certain animals are included. (auth) (TSS)

49283 THE VEGETATION STRUCTURE OF A PUERTO RICAN RAIN FOREST BEFORE AND AFTER SHORT-TERM GAMMA IRRADIATION. Smith, Robert Ford. Athens, Ga., Univ. of Georgia, 1967. 184p.

Thesis.

The structure of a stand of rain forest was studied before and for one year after it was subjected to three months of γ radiation from a 10,000 Ci ^{137}Co source. Floristic analyses showed that the vegetation studied was near an abrupt boundary between Montane Rain Forest and Tropical Rain Forest; this junction was associated with a change in the soil from relatively aerobic to anaerobic conditions probably due to factors of drainage. Profile drawings were made and 219 vascular species were listed in the study area of approximately five hectares. Structural analysis was by lifeforms: synusiae; the climate preference of the species; and the primary forest or secondary forest placement of the species. When the number of species was plotted with the log of sampled individuals, the relationship was linear in several synusiae. The total vegetation diversity averaged 65 species per 1,000 individuals. The half-life of seedling populations in the forest shade was 6.5 months. Vegetation destruction, indicated by plants with leafless twigs, extended to and became relatively stabilized at 8,000 roentgens. Primary forest species in both the canopy and the understory appear more sensitive than secondary forest species. Secondary forest species were generally stimulated in growth of twigs and production of leaves by sub-lethal doses. Few malformed new leaves were observed. Root sprouting occurred only where the trunk base was shielded from direct irradiation; this was probably due to the shallowness of the roots in the study area. The coverage due to seedlings and herbs in the irradiated zone was 6 percent after one year; they were composed mainly of secondary forest species that do not sprout in the forest shade. Phytolacca icosandra, an herbaceous species of full sunlit areas, was the aspect dominant after one year of recovery; it had mottled leaves suggesting somatic mutants. (Disser. Abstr.)

Genetics and Cytogenetics

Refer also to abstracts 49283, 49459, 49603, 49636, 49639, 49640, and 49642–49644.

49284 (NYO–2740–5, pp 201–66) BIOPHYSICS. (Columbia Univ., New York. Radiological Research Lab.).

The relative biological effectiveness of monoenergetic neutrons of different energy levels was studied in relation to the opacification of tissues and genetic effects in Drosophila melanogaster. Cultured Chinese hamster fibroblasts were x-irradiated to determine the effects on survival and clone formation (reproducibility). Cultures of Escherichia coli B/r were uv-irradiated and the incidence of lethality and mutation to prototrophy were determined. The effects of dose on the incidence of neutron-induced mutations in plant leaf embryos were also determined. (E.R.B.)

49285 RESPIRATORY-DEFICIENT MUTANTS IN SACCHAROMYCES LACTIS. Herman, Alberta I.; Griffin, Patricia S. (Dept. of Agriculture, Peoria, Ill.). J. Bacteriol., 96: 457–61 (Aug. 1968).

Six independent ultraviolet-induced respiratory-deficient mutants (petites) of Saccharomyces lactis were isolated and characterized. Two possessed a normal cytochrome spectrum, another displayed an increased level of all the cytochromes, and three suffered from a partial or complete loss of one or more of the cytochromes a, b, c, and c_1. All of the mutants were segregational petites; none was vegetative. Determination of linkage relationships between mutants was restricted because matings between mutants, homozygous or heterozygous, for loci affecting cytochrome content were blocked at various stages in the mating-sporulating sequence. At least three of the petites were genetically nonidentical. Three of the mutations appeared to occupy loci within the same linkage group; two of the three mutations that mapped within this region were cytochrome-deficient. Growth at high or low temperatures, under increased osmotic pressure or in media supplemented with various fatty acids or sterols, did not relieve the physiological defects in these mutants. Reasons for the differences in survival of segregational and vegetative petites within this species are examined. (auth)

49286 METHODS FOR COMPUTING LYMPHOCYTE KINETICS IN MAN BY ANALYSIS OF CHROMOSOMAL ABERRATIONS SUSTAINED DURING EXTRACORPOREAL IRRADIATION OF THE BLOOD. Sharpe, Heather B. A.; Dolphin, G. W.; Dawson, K. B.; Field, E. O. (Radiological Protection Div., Harwell, Eng. Royal Marsden Hospital, Sutton, Eng.). Cell Tissue Kinet., 1: 263–71 (July 1968).

Data on lymphocyte kinetics may be derived in patients undergoing treatment by extracorporeal γ irradiation of the blood by studying chromosome aberrations induced in their lymphocytes; the aberrations are observed when the lymphocytes are stimulated by phytohaemagglutinin to divide in culture. Two methods of analysis are described, one depends on the total number of dicentrics scored, the other employs the dilution principle, regarding each lymphocyte bearing one or more aberrations as specifically labeled. Two parameters may be calculated: the mean residence time of lymphocytes in the blood and the size of the extravascular pool of lymphocytes in the body. In a patient with Hodgkin's disease, the mean residence time was found to be 4.7 to 7.5 min and the extravascular pool 800 to 1070 g. (auth)

49287 DARK RECOVERY PROCESSES IN ESCHERICHIA COLI IRRADIATED WITH ULTRAVIOLET LIGHT. I. EFFECT OF rec$^-$ MUTATIONS ON LIQUID HOLDING RECOVERY. Ganesan, Ann K.; Smith, Kendric C. (Stanford Univ., Palo Alto, Calif.). J. Bacteriol., 96: 365–73(Aug. 1968).

Various derivatives of Escherichia coli K-12 were examined for liquid holding recovery, a type of recovery originally observed in E. coli B irradiated with ultraviolet light. Although most of the K-12 derivatives tested showed relatively little or no recovery under our conditions, four of the six independent rec$^-$ mutants examined, those carrying recA1, rec-12, recA13, and rec-56, respectively, displayed marked recovery. These mutants are distinguished from rec$^+$ strains by their increased sensitivity to ultraviolet radiation and decreased ability to undergo genetic recombination. Two of them have also been reported to release large amounts of their deoxyribonucleic acid as acid-soluble material, especially after irradiation. None of the three uvr$^-$ mutants examined, containing uvrA6, uvrB5, or uvrC34, showed comparable liquid holding recovery. The one rec$^-$ uvr$^-$ derivative tested, carrying recA13 and uvrA6, did not appear to undergo liquid holding recovery, although recA13 uvr$^+$ strains did. Genetic analysis of one strain, a recA13 mutant, indicated that all the rec$^+$ derivatives obtained from it by conjugation, transduction and reversion, had lost the property of showing liquid holding recovery. From these results, we conclude that in E. coli K-12 the expression of liquid holding recovery depends upon certain rec$^-$ mutations. (auth)

49288 GENETIC EFFECTS OF X-IRRADIATION ON QUANTITATIVE TRAITS IN MICE AS ESTIMATED FROM A DIALLEL CROSS. Singer, Arthur Chester. Urbana, Ill., Univ. of Illinois, 1967. 147p.

Thesis.

The experiment included a single-cross study and a double-cross study; both were analyzed using a diallel-cross analysis. The single-cross study included all possible matings of the seven inbred strains of mice, C57BL/6J, RF/J, CBA/J, A/J, C57BL/10J, C57BR/cdJ, and C3HeB/FeJ, all of which were obtained from Jackson Memorial Laboratory, Bar Harbor, Maine. Six replications of each of the 49 possible matings were made with the males of three replications receiving 150 R x irradiation. Each mating was allowed opportunity to produce three litters, but only 574 of a possible 882 litters were obtained. Number of mice per litter was analyzed at birth and 42 days of age and though not significant, litters by irradiated males contained 0.50 fewer mice per litter than litters by non-irradiated males at both ages. Crossbred litters were significantly larger by 0.8 and 1.1 mice at birth and 42 days; inbred strains differed significantly at 42 days while differences in general combining ability were significant only at birth. Litter weights were recorded at 2, 12, 22, 32, and 42 days. Litters from x-irradiated sires were significantly heavier by 0.13

and 0.44 grams per mouse at 2 and 42 days. Crossbred litters were significantly heavier than inbreds at all ages, the differences being 0.43 and 3.03 grams per mouse and 2 and 42 days. Maternal effects and general and specific combining ability were significant at all ages except for general combining ability at 2 days. Litter weights at 42 days were adjusted for number per litter and per cent males per litter while all other weights were adjusted for number per litter. Individual measurements of body length, heart girth, and weight taken on all first litters at 42 days contained significant heterotic, maternal, general and specific combining ability effects as well as significant effects associated with irradiation and sex. The double-cross study included all possible double crosses resulting from the mating of six selected single crosses. Except for three cases where only two female mice were available, three replications of each of the 30 mating types were made. One hundred per cent reproductive efficiency was obtained with each female having two litters. Number of mice per litter was analyzed at birth and 42 days of age and was not significantly affected by residual x irradiation effects nor were any of the diallel effects significant. Litter weights were recorded at 2, 12, 22, 32, and 42 days; the analyses of these data indicated that only the maternal effects were significant at all ages. The litter weights were adjusted in the same manner as in the single-cross analyses. Individual measurements of body length, heart girth, and weight taken on all litters at 42 days contained significant maternal and sex effects for all measurements; however, general combining ability and reciprocal effects were significant only for body length and weight. The single crosses used as parents had 2.3 more mice per litter at birth than did the inbreds. (Disser. Abstr.)

49289 RADIOBIOLOGICAL EFFECTS OF RADIOIODINE THERAPY; CHROMOSOMAL CHANGES. Nofal, Mohamed Magd Eldin. Ann Arbor, Mich., Univ. of Michigan, 1967. 151p.
Thesis.

Evaluation of the radiobiologic effects of irradiation from ^{131}I therapy for thyrotoxicosis and thyroid carcinoma was performed through analysis of chromosomal changes in peripheral leukocytes. After a short-term culture, lymphocytes were analyzed for chromosomal changes. Abnormalities in count and morphology were analyzed through direct microscopic visual scoring. Studies were made on: Sixty-five hyperthyroids treated 3 to 14 years previously with 6 to 54 mCi ^{131}I. Their chromosomal analysis was compared to that of 27 controls matched for age and sex. Chromosomal analysis was done on 15 treated hyperthyroids before and one-half hour after an oral dose of ^{131}I ranging from 7 to 13 mCi. Chromosomal studies were performed on 12 thyroid cancer patients before and at intervals up to 48 hours following a larger dose of ^{131}I ranging from 150 to 208 mCi. In all these groups, evaluation under circumstances described suggested a statistically higher incidence of abnormalities in the study groups than in the control groups. The incidence of abnormalities was highest shortly after irradiation. No hematologic phenomena seemed to accompany these abnormalities, either shortly after irradiation or as late manifestation. Repeat study of the chromosomal changes was performed on the latter two groups (treated hyperthyroids and thyroid cancer patients) using a more accurate and detailed method of analysis, eliminating investigator bias. Results obtained under these circumstances suggested no statistically significant difference between the chromosomal picture before and after ^{131}I therapy, in both hyperthyroid and thyroid cancer patients. The explanation for the discrepancy and comparison with the literature were discussed. Data also showed no significant difference in the chromosomal analysis between non-irradiated hyperthyroid patients and patients with thyroid carcinoma, suggesting no specific effect of either disease on the chromosomes. (Disser. Abstr.)

49290 CYTOGENETIC OBSERVATIONS WITH REFERENCE TO A CASE OF ERYTHREMIA TREATED BY GENERAL TELE-IRRADIATION. Schmitzer, G.; Norz, L.; Maximilian, C.; Rizea, Irina (Coltea Hospital, Bucharest). Rum. Med. Rev., 21: 75-8(July-Sept. 1967).

Chromosome aberrations were studied in a woman receiving x-ray therapy over a large part of the body for polycythemia vera. In single 5- to 60-R doses she received a total dose of 180-kV x rays of 870 R over the whole body and 840 R additionally to the shanks. The karyotype of 70 bone marrow cells showed relatively few cells with 46 chromosomes and a normal distribution. An abnormal distribution was the most characteristic aberration encountered in this case. In 40 of the 70 cells studied (57%) chromosomes from two or three groups were found. As a rule, there was an additional or missing chromosome in groups C-F and G. There were frequent structural anomalies; in 44 (62.8%) of the cells dicentric chromosomes, broken chromosomes, chromosomes of abnormal length, ring-like chromosomes, and chromatid aberrations were noted. In other cells, associated numerical and structural anomalies were almost constantly found. Dicentric chromosomes, chromatid aberrations, fragments, and chromosomes of abnormal length were found in 11 cells; another eight cells showed chromosomes of unusual length, deletions, and fragments. Only four of the total of 70 cells (5.6%) presented neither numerical nor structural aberrations. The incidence of aberrations was surprisingly high, especially as the patient was examined several years after irradiation. These findings suggested that irradiation brought about frequent aberrations in the number and shape of chromosomes, aberrations that tended to become permanent. (BBB)

49291 COMPARISON OF RECIPROCAL RECURRENT AND CONVENTIONAL SELECTION FOR TRAITS WITH LOW AND MODERATE HERITABILITIES. Kincaid, Harold Leland. Urbana, Ill., Univ. of Illinois, 1967. 128p.
Thesis.

The selection of two traits, fecundity and thorax length was investigated in Drosophila melanogaster exposed to 500 R x radiation. Complete least squares analysis of the fecundity data indicated that the two most important sources of variation in the data were day of evaluation and generation of selection accounting for twenty-seven per cent of the total variation. No significant difference ($p = 0.05$) was found between irradiated and non-irradiated replicates though the irradiated group was 2.8 per cent larger. Complete least squares analysis of thorax length data indicated that the two most important sources of variation in the data were sex of the offspring and generation of selection accounting for sixty-nine per cent of the total variation. No significant difference was found between reciprocal recurrent selection and mass selection though mass selection was 0.3 per cent larger than non-irradiated thorax length populations, significant at the one per cent level. Regression analysis of generation means for all populations indicated that after twenty-two generations of selection, for both fecundity and thorax length, reciprocal recurrent selection populations were larger than mass selected populations. This difference was significant ($p = 0.01$) for the thorax length data but was non-significant for the fecundity data. This analysis also indicated that irradiated populations after twenty-two generations of selection, were larger than non-irradiated populations by 4.5 and 1.9 per cent for fecundity and thorax length respectively. The difference, however, was non-significant for both traits. Realized heritability estimates after twenty-two generations of selection were obtained for both thorax length and fecundity. These estimates for the thorax length populations were 0.125, 0.122, 0.149, and 0.105 for reciprocal recurrent, non-irradiated; mass selected, non-irradiated; reciprocal recurrent, irradiated; and mass selected, irradiated. The same estimates for the fecundity populations were −0.003, −0.039, −0.004, and −0.011. These values indicated that reciprocal recurrent selection gave slightly higher gains from selection, but none of the differences was significant. (Disser. Abstr.)

49292 GAMMA-RAY-INDUCED MUTATIONS IN DROSOPHILA MELANOGASTER OOCYTES: THE PHENOMENON OF DOSE RATE. Himoe, Eleanor. Madison, Wis., Univ. of Wisconsin, 1968. 59p.
Thesis.

Wild-type Canton-S Drosophila melanogaster females, 0 to four hours old, were irradiated with ^{137}Ce γ rays to test for an effect of the dose rate of irradiation on the induction of sex-linked recessive lethal mutations in oocytes. The procedure for collecting and mating the females was designed to sample, insofar as possible, only oocytes that were in stage 7 at the time of irradiation. In the first two experiments, a dose of 4000 rads was given at 9.5 rads per minute (dilute) and at 334 and 312 rads per minute (intense). As a control for any age changes occurring during the time of treatment, two separate intense irradiations were given, one immediately preceding and one following the dilute irradiation, which was of about seven hours duration. In the first experiment, the induced mutation frequencies were: dilute, 2.92 ± 0.55%; intense-1, 2.42 ± 0.49%; and intense-2, 2.75 ± 0.58%. In the second experiment the frequencies were: dilute, 4.43 ± 0.69%; intense-1, 3.65 ± 0.62%; and intense-2, 4.49 ± 0.77%. There were no significant differences between the induced mutation frequencies in either experiment. A third experiment was performed where the dilute treatment was reduced to 4.8 rads per minute, and the total dose delivered was 2000 rads. The observed induced mutation frequencies were: dilute, 1.98 ± 0.29%; intense-1, 1.73 ± 0.29%; and intense-2, 2.76 ± 0.36%. Again, there was no significant difference among the mutation frequencies. A small sample of 52 lethals recovered from the 4000 rad dilute and the intense irradiations was examined cytologically in salivary gland chromosomes for visible chromosome aberrations. There was no evidence for a difference in aberration frequency due to the different treatments. The overall frequency of gross chromosomal aberrations was 2/52, or

3.8%. It was concluded that, for the range of dose rates studied, there was no evidence for an effect of dose rate of irradiation on the frequency of sex-linked lethals recovered from irradiated stage 7 oocytes of Drosophila melanogaster females. (Disser. Abstr.)

49293 GENETIC EFFECTS OF PRENATAL X-IRRADIATION IN MICE. Chaudhary, Ram Parkash. Chicago, Univ. of Illinois, 1967. 105p.

Thesis.

An inbred and a hybrid strain of mice and their reciprocal crosses were used to investigate the effects of prenatal irradiation on litter size and average litter weight of the directly exposed embryos and their two subsequent unirradiated generations. Pregnant females were exposed to a single whole body X-ray dose of either 0, 25, 50, or 75 R on day 5 or 10 of gestation, and litter size at days 0, 7, 14, 21, 28, and 35, and average weight at days 7, 14, 21, 28, and 35 were analyzed by the method of least squares. Average weight was more sensitive to the direct effect of irradiation than was litter size. The effects of irradiation were not clearly evidenced until the litters were weaned, suggesting that during the preweaning period growth was largely dependent upon the performance of the mother, but after weaning the individual's own genotype was in control. The fact that no effect of irradiation on weight detected suggested that the mutations induced by the X ray doses given were too few and of too little aggregate effect to be detected. A dose of up to 75 R delivered at either of two developmental stages had little effect on subsequent reproduction. Greater litter size in generation three at a dose of 50 R, coupled with higher survival than at 75 R could evidence an induced heterosis. (Disser. Abstr.)

49294 CARIOTYPICAL VARIATIONS INDUCED IN EHRLICH'S ASCITE TUMOR CELLS BY IONIZING RADIATIONS. Piccotti, F.; Cirillo, R.; Toscano, G.; Pons, A. Isoardi (Univ., Turin). Med. Nucl.-Radiobiol. Lat., 10: 439-56(1967). (In Italian).

Cariotypical modifications of Ehrlich's ascites tumor cells from mice were examined at successive time intervals after x irradiation with 500 R. Results showed greater dispersal of cariotypes with a different number of chromosomes and with a different chromosome pattern from non-irradiated controls. A notable increase of hyperploidism was also shown. These variations, secondary to mitotic and chromosomic alterations, tended to diminish with time, so that the cell population reestablished its original cariotype with relative variations, as in non-irradiated controls 72 hours after irradiation. The relation between cellular survival and cariotypical constitution is discussed. (auth)

49295 PRODUCTION OF ACTION SPECTRUM INDUCED MUTATIONS IN ACTINOPHAGES WITHOUT PRELIMINARY INTRACELLULAR REPLICATION IN THE PHAGE SENSITIVE STRAIN. Alikhanyan, S. I.; Mkrtumyan, N. M. Microbiology (USSR) (Engl. Transl.), 34: 81-7(Jan.-Feb. 1965).

Mutations were obtained in actinophages (type I, lysing Actinomyces) by exposure to uv, nitrous acid, sarcolysin, and chlorambucil. Host mutations caused in actinophage by nitrous acid appeared only after inoculating the treated phage on a mixed population but not on a stable population, thereby confirming the replication mechanism of mutations induced by the acid. Host mutations caused by sarcolysin and chlorambucil arose upon direct inoculation in the resistant strain. It is suggested therefore that mutations induced by alkylating compounds arise in the directly treated chromosome without preliminary replication of the DNA molecule in the cells of the susceptible strain. Host mutations caused by uv-radiation appeared in part during chromosome treatment with the mutagen without preliminary replication and, in part, via the mechanism linked with replication in a susceptible strain. (BBB)

49296 AVIRULENT MUTANT OF A STRAIN OF ORNITHOSIS AGENT OBTAINED BY GAMMA IRRADIATION. Strauss, J.; Seeman, J. (Inst. of Epidemiology and Microbiology, Prague). Amer. J. Vet. Res., 29: 1837-42(Sept. 1968).

A strain of ornithosis agent (psittacosis virus) of reduced virulence for white mice was obtained by irradiating a virulent strain with gamma rays. Lyophilizates of egg yolk sac suspensions in modified Bovarnick medium (dilution end point 10^{-4}) were irradiated initially at the dose level of 5.0×10^5 R and in the next passage at the level of 2.5×10^5 R and then were propagated again in chicken embryo yolk sacs. A mutant was obtained that was nonpathogenic for mice when administered by the intracerebral or intranasal route. Mice vaccinated by intranasal and intraperitoneal administration of the radiation-attenuated mutant were not protected against intranasal challenge exposure with the virulent parent strain. However, vaccination by intracerebral inoculation protected mice against 80 median lethal doses (LD_{50}) of the virulent parent strain. (auth)

49297 RADIOSENSITIVITY AND NUCLEOLAR ORGANISERS. Moutschen, J. (Univ., Liege). Med. Nucl.-Radiobiol. Lat., 10: 397-404(1967). (In Italian).

In the plant Nigella damascena L., three satellited chromosomes are responsible for the nucleolar organization. After irradiation with γ rays, germinating seeds contain cells with abnormal numbers of nucleolar organizers. The radiosensitivity of these root tip cells to a second γ irradiation was measured. Cells with abnormal numbers of nucleolar organizers were much more radiosensitive than normal cells. Possible reasons for this increase are discussed. (auth)

49298 INDUCED CROSSING-OVER IN THE PRESTERILE BROODS OF DROSOPHILA MELANOGASTER MALES. Hannah-Alava, Aloha (Univ. of Turku, Finland). Genetica, 39: 94-152 (1968).

The results from two experiments on induced crossing-over in the germ cells of 3000 R x irradiated adult Drosophila melanogaster males, heterozygous for 12 to 13 third-chromosome mutant loci, support the premise that the F_1 offspring recovered in the 6 to 8 day broods are derived mainly from cells that had been primary spermatocytes at the time of irradiation. The frequency of exchange in the third-chromosome following irradiation of the adult male is in the order of 0.01% for the 1 to 3 and 4 to 5 day broods, 0.15% for the 6 to 7 day broods and 0.31% for the 8th day brood in the pooled data from 18 experiments. The spontaneous rate for the third-chromosome is in the order of 0.001%. The rather great variance among the experiments in time of recovery of the first crossovers and the frequency of exchange during the time of sampling the spermatocytes and definitive spermatogonia, ranging from none to a 20-fold increase (over the spontaneous rate) in the 6 to 8 day broods, and from none to a 10 to 50-fold increase from the 6 to 8 to the 9 to 11 day broods, can be attributed to the brood procedures or mating pressure, the effectiveness of ascertainment of crossing-over, particularly in the early broods, and the dosages used by the different investigators. The lack of a dose-frequency relationship in the broods prior to the period of peak sterility is caused, at least in part, to lethal-loss of the cells with induced exchange. The evidence from the two experiments also supports the premise that there may be different types of exchange-induction with a causal relationship between the time of induction and the site in the chromosome. The higher relative frequency of multiple crossovers and noncentric exchanges among the recombinants recovered in the 1 to 7 day broods, as compared to their frequency in the spermatogonial broods, suggests that there may be a difference in the mode of induction or transmission of recombinant chromosomes in different stages of spermatogenesis. The relatively high incidence of F_1-sterility of the recombinants and homozygous lethality of the recombinant chromosomes points to the possibility that either the meiotically-induced exchanges are intrachromosomal aberrations frequently accompanied by duplications or deficiencies due to breakage at nonidentical loci, or homologous chromosomes sensitive to the induction of exchange are more likely to be hypersensitive to the induction of genetic damage with detrimental fertility and viability effects. (auth)

49299 HEAT-INDUCED CHANGES OF THE RADIOSENSITIVITY OF THE TOMATO. Palenzona, D. L.; Calvar, J. D.; Grillo, E. G. (Univ., Bologna. Univ., Pavia). Genet. Agr., 21: 238-48 (Aug. 30, 1967). (In Italian).

Seeds from two tomato varieties, Rutgers and Earliana, were given heat treatment during germination. The heat treatment germinated the seeds at 34°C. Heat treated as well as untreated plants were self-fertilized for two subsequent generations: at the third generation seeds from both groups of plants were x-irradiated. Two irradiation experiments were performed: one with doses of x rays ranging from 0 to 400 KR to study radiosensitivity, another using three doses of x rays (0, 1, 2 KR) in order to obtain information about mutagenic effects. The characters studied were: seed lethality, pollen lethality, mean number of seeds per fruit, mean weight of seeds per fruit, and mean weight of fruits per plant. The results obtained suggest that the effect of heat treatment interacts with the effects of the ionizing radiations, this interaction being manifested in all the characters considered; moreover the heat treatment seems to affect the intensity of manifestation of intra-somatic selection. Given the nature of the characters studied, i.e., that they are determined mainly by the mutagenic effects of ionizing radiations, it is suggested that heat treatment produces modifications in the structure of the affected organism that are transmitted to subsequent generations and modify radiosensitivity and the reponse to the mutagenic action of ionizing radiations. (auth)

49300 RESULTS OF A THREE YEAR TEST WITH MUTANTS OF DURUM WHEAT IN MARCHE REGION. Mosconi, C. (CNEN, Rome). Genet. Agr., 21: 173-85(Aug. 30, 1967). (In Italian).

Results concerning a three year trial (1963 to 64/1965 to 66) in the region of Marche (Central Italy) are reported. The trial was performed at four different nitrogen levels: 0, 40, 80, and 120 kgs. of NO_2 per hectare, comparing the Cappelli durum wheat variety, three radioinduced mutant lines of Cappelli (Cp B 132, Cp B 144, and Cp C 48) and the bread wheat variety Campodoro. The aims were to test the possibility of introducing durum wheat in damper and more fertile environments than the traditional ones, and to evaluate comparatively the response of the tested lines to increasing nitrogen levels. Considering particularly the results of the last two years, more representative of the average local climatic conditions, it is possible to point out that; Campodoro yields alternatively more and less than the best durum lines, i.e. CP B 132 and Cp C 48, all mutant lines of Cappelli, are better than Cappelli itself; Cp B 132 and Cp C 48 for amount of yield, Cp B 144 for kernel quality. All tested lines and varieties were characterized by a positive response to the increase in nitrogen supply, both by increasing yield and a reduction in yellow berry, and Campodoro is completely lodging-resistant. Cp B 132 has also a very good standing ability, lodging only to a very limited extent. It is concluded that the results, even though concerned only with a short three year period, support the introduction of durum wheat cultivation in the areas considered. (auth)

49301 PRODUCTION OF ANEUPLOIDS THROUGH GAMETES' IRRADIATION IN DURUM WHEAT. Martini, G.; Bozzini, A. (Univ., Pisa, Italy. CNEN, Rome). Genet. Agr., 21: 139-47 (Aug. 30, 1967). (In Italian).

Spikes of Cappelli durum wheat were treated with γ rays (total exposure 235 R in 150 min) at the stage corresponding to mononucleate, binucleate, and trinucleate pollen. Analysis of the mean number of caryopses per spikelet showed that there were no clear differences in fertility between spikes treated at the binucleate and trinucleate pollen stage, while fertility was reduced in spikes treated at the mononucleate stage. Cytological analysis of root tips of 441 plants derived from treated material showed that, in this case too, the most efficient irradiation stage is the mononucleate one, yielding the highest number of aneuploid individuals. Cytological analysis showed, moreover, that the aberrant individuals most frequently found have a chromosome number of $2n = 27 + 1$ centric fragment (13 plants out of 31). Types with $2n = 27$ were also found with fairly high frequency (five cases). It is interesting that nearly all the aberrant individuals were aneuploids with a deficiency of all or part of entire chromosomes, while only in two cases polysomic individuals were found. It is concluded that γ irradiation of gametes during sporophyte development is a good method for obtaining aneuploids in durum wheats. (auth)

49302 X-IRRADIATION EFFECTS ON HIBISCUS CANNABINUS L. AND HIBISCUS SABDARIFFA L. Singh, D. P.; Mitra, G. C. (Jute Agricultural Research Inst., Barrackpore, India). Genet. Agr., 21: 86-100(Aug. 30, 1967).

Dry seeds of two varieties of each of the two important bast fibre producing species, Hibiscus cannabinus and H. sabdariffa were exposed to different doses of hard x rays, ranging from 20,000 R to 140,000 R units at an interval of 20,000 R between the doses. Germination percentage was recorded under two conditions; in Petridish at room temperature, and in field. No marked difference was observed in germination under both conditions, except in H. sabdariffa that showed reduction in germination in field but increase in Petri-dish. Variety HC-583 of H. cannabinus, however, showed an increasing trend in germinability. In both cases, doses at 20,000 R induce relatively few morphological aberrations in X_1 generation, and effective doses may be said to begin at this level. The largest number of abnormalities in X_1 was observed in leaf traits followed by stem characters, and male and female sterility. No marked sterility was observed in H. cannabinus, but H. sabdariffa showed an increase in sterility with increase of dose. The majority of the X_1 aberrations were not transmitted to the next generation and were thus transient. The transmissible variations were those that appeared in the X_2 generation and there-after. Seven heritable variations have been isolated from different generations. Most of the aberrations, except the dark red stem, were recessive changes at one or two loci. H. sabdariffa ($2n = 72$) was found to be more sensitive towards x rays than H. cannabinus ($2n = 36$). (auth)

49303 STUDIES ON THE EFFECTS OF IONIZING RADIATIONS IN NICOTIANA RUSTICA. Krishnaswami, R. (IARI, Delhi). Genet. Agr., 21: 35-48(Aug. 30, 1967).

Dry seeds of Nicotiana rustica var. NP 220 were irradiated with different doses of fast neutrons and x rays. Observations were made on meiosis, pollen fertility, and morphological changes in M_1 generation and frequency of chlorophyll and viable mutations in M_2 generation. Even though the radiations had pronounced effect on meiosis, fertility, and morphology of vegetative and floral parts in the treated generation the frequency of induced macromutations was very low. The possible reasons for this observation are discussed. (auth)

49304 DIALLEL ANALYSIS OF QUANTITATIVE CHARACTERS IN VARIETIES AND RADIOINDUCED MUTANT LINES OF TRITICUM DURUM. Bagnara, D. (CNEN, Rome). Genet. Agr., 21: 313-37(Nov. 30, 1967).

A diallel analysis of F_1 and parental durum wheat material from a cross among six lines was carried out according to the methods of Hayman and Jinks. The parents were Cappelli, Lakota, and four radioinduced mutant lines of Cappelli. For seven quantitative characters estimates were obtained for: general and specific combining ability, direction of dominance, ratio of dominant over recessive alleles, average degree of dominance, symmetry in the distribution of alleles, eventual occurrence of maternal effects, and non allelic interactions, number of factors controlling the character, heritability etc. Results have shown the existence of differences in the degree of either dominance or expression between Cappelli and its derived lines at the level of most characters and the specificity of these differences in each mutant. Most characters exhibited partial dominance, with the exception of the number of spikelets per main ear, which showed over-dominance together with the lowest heritability. The direction of dominance was in most cases positive. The expression of the characters is determined by a minimum of one and a maximum of five controlling factors. Lakota was the line giving rise most frequency to no allelic interactions. Results are further discussed about the guidance the evaluated parameters can offer in improving selection procedures in the following generations. (auth)

49305 GENETIC EFFECTS OF GAMETOPHYTE IRRADIATION IN BARLEY. Donini, B.; Devreux, M.; Scarascia Mugnozza, G. T. (CNEN, Rome). Genet. Agr., 21: 338-9(Nov. 30, 1967). (In Italian).

Spikes of barley were acutely irradiated (1500 R, 93 R/hr) in a γ field at different developmental stages of the gametophytes. The two gametophytes were irradiated both together and independently. M_1 plant progenies were analyzed in a greenhouse to detect the induction of chlorophyll and morphological mutations at the seedling stage. 2961 M_1 progenies were analyzed, the total number of spikes per plant being between 6–12; the total frequency of mutations (chlorophyll + morphological) was 2.86% after irradiation of the male gametophyte, 2.55% after irradiation of the female gametophyte and 5.15% after irradiation of both gametophytes. Analysis of the 94 M_1 progenies, that segregated for mutation, showed the presence of mutations in all spikes of M_1 plants, that therefore have to be considered heterozygotes for mutation. Irradiation of barley gametophytes at different developmental stages leads then to the formation of heterozygous plants, for the induced mutations, overcoming in this way the chimeric situation obtained after irradiation of a multicellular organism, such as the embryo. (auth)

49306 ANALYSIS OF GENETIC VARIABILITY IN ALFALFA AFTER X-RAY TREATMENTS OF SEEDS. Scossiroli, R. E.; Sarti, A. (Univ., Bologna. Stazione Sperimentale di Praticoltura, Lodi, Poland). Genet. Agr., 21: 340-52(Nov. 30, 1967). (In Italian).

X ray treatments applied to the seeds of two alfalfa varieties, Florida and Cremonese, induce changes in the mean values and in the relative estimates of genetic variability (heritability) for a few production traits. Such changes are still maintained in R_2 and R_3 generations obtained under selfing or open pollination, with different behavior according to the variety, the irradiation dose, and the trait considered. In general, the increase of genetic variation points to larger possibilities for breeding in the treated population. (auth)

49307 IRRADIATED MENTOR POLLEN: ITS USE IN REMOTE HYBRIDIZATION OF BLACK COTTONWOOD. Stettler, R. F. (Univ. of Washington, Seattle). Nature (London), 219: 746-7 (Aug. 17, 1968).

The successful use of irradiated mentor pollen in hybridizing the North American black cottonwood Populus trichocarpa is reported, and also the successful induction of haploid parthenogenesis using this technique. The studies formed part of an investigation of the usefulness of homozygous tree material in forest genetics research. The pollen was exposed in air-dried condition to 100 kR of ^{60}Co gamma radiation. (UK)

49308 USE OF RADIOACTIVE ISOTOPES IN SELECTION OF VEGETABLES. Kvasnikov, B. V.; Dolgich, S. T. (Scientific Research Inst. of Vegetable Economy, Moscow). Vestn. Sel'skokhoz. Nauki (Moscow), No. 10, 6-12(Oct. 1965). (In Russian).

Some radioisotopes (^{32}P, ^{35}S, and ^{60}Co) were used for inducing early ripening of fruits and seeds of plants; for the production of improved varieties of tomatoes, onions, carrots, garden beets, cucumbers, squash, and melons; to increase cabbage resistance to clubroot; and to irradiate dry seeds of the above plants. The isotopes ^{32}P and ^{35}S proved to be very useful in experimental tests in the induction of valuable biological and nutritional properties of plants estimated to be four to five times greater than those obtained under the usual agricultural-chemical growth stimulation conditions. The early ripening and selective breeding of plants were successfully obtained when mutations were induced by ^{60}Co γ irradiation, according to the tabulated data. The ^{60}Co irradiation (single doses of 350 and 700 R and 2500 R total doses in 1st generation; 20,000 to 25,000 R total doses in 3rd generation) of seeds induced optimal effects on tomatoes, onions, carrots, and garden beets; e.g., a parent 37-cm high tomato plant produced (with a total of 2095 Rad) a 25-cm high, early maturing hybrid, that yielded (by the 5th generation) from 11 to 20% higher productivity and 13% higher weight of the fruit. Consequently, to produce other new plants that were economically more valuable, onions, carrots, garden beets, cucumbers, squash, and melons were exposed to increased radiation doses, with favorable results by the 3rd generation. (BBB)

49309 THE ISOLATION AND SOME PROPERTIES OF RADIATION-SENSITIVE MUTANTS OF MICROCOCCUS RADIODURANS. **Moseley, B. E. B. (Univ. of Edinburgh). J. Gen. Microbiol., 49: 293-300(1967).**

Treatment of the radioresistant bacterium M. radiodurans with uv radiation and N-methyl-N'-nitro-N-nitrosoguanidine (NG) resulted in the isolation of three mutants highly sensitive to uv radiation. They were also sensitive to ionizing radiation and to the action of NG. The reduction in the length of shoulder of the survival curve for one mutant (strain UV-38) was much greater (28-fold for uv and 5-fold for ^{60}Co γ radiation) than the increase in exponential slope, viz., 5-fold for uv radiation and 2-fold for γ radiation. For strain UV-38 the increase in sensitivity to uv radiation was greater than that for γ radiation. The same was true for other strain (UV-17), the reduction in the shoulder being 28-fold uv radiation and 7-fold for γ radiation, while the exponential slope increased by factors of ten and seven respectively. The concentrations of sulfhydryl groups in bacteria of the wild type and the mutants were not significantly different. Although the mutants were more sensitive to mitomycin C than the wild type, the resistance of the latter was low. It is suggested that the DNA repair mechanism in the wild type operates very efficiently for the removal of single strand damage but not for that which involves cross-linking. (BBB)

49310 EFFECT OF FRACTIONATED DOSES OF RADIATION ON RECOMBINATION. **Lawrence, C. W. (Atomic Energy Research Establishment, Wantage, Eng.). Heredity, 23: 143-6(Feb. 1968).**

Low, nonlethal doses of ^{60}Co γ radiation change gene recombination in Chlamydomonas reinhardi, only if given during two short meiotic stages. Preleptotene irradiation decreases the frequency of recombination while treatment in late zygotene or pachytene gives an increase. The response at both stages may be due to interference in the synthesis of DNA, and processes leading to recombination may occur in normal, unirradiated cells during, or close to, these responsive periods. A comparison was made between the recombination frequencies in zygospores irradiated during both stage 1 (preleptotene) and stage 2 (late zygotene-pachytene) and those irradiated in stage 1 only. Zygospores irradiated during both stage 1 and stage 2 received 12 dose increments. In one series each increment was 750 Rad and in another 1000 Rad, delivered in air at a dose rate of 14.65 kR/min. A single acute dose of 1000 Rad gives about a half of the maximum response to acute doses at both stage 1 and stage 2, and 750 Rad gives about $\frac{1}{3}$ of the maximum response. The results demonstrated that the capacity to respond to irradiation at stage 2 was not diminished by prior irradiation at stage one. In fact, this capacity was doubled, but the difference may merely reflect the difficulty of inferring changes in the frequency of crossing-over from recombination data. The results appeared, therefore, to rule out a radioinduced inhibition of pairing at stage 1 and indirectly support the two-step model of crossing-over. (BBB)

49311 SEGREGATION FREQUENCIES OF INDUCED CHLOROPHYLL MUTANTS IN BARLEY. **Doll, Hans (Danish Atomic Energy Commission Research Establishment Riso, Roskilde). Hereditas, 59: 464-72(1968).**

The segregation of a random sample of 49 chlorophyll mutants derived from γ-irradiated barley was studied. The segregation frequency of the mutants in the offspring of their heterozygous carriers varied from 10 to 26%, the mean frequency being 22.4%. About one-fourth of the mutants segregated with a frequency significantly lower than the expected 25%. The frequency of the remaining mutants did not deviate substantially from the Mendelian expectation, and no mutant exceeded the expectation significantly. Possible reasons for the deviating segregation frequency of some of the mutants were investigated by comparing the germination frequencies of the offspring of mutant heterozygotes and wild-type homozygotes as well as the fertilities of these two genotypes. No difference was found in fertility, and only in one case could the significant deficit of a mutant be a consequence solely of low germination capacity of the mutant seeds. It was concluded that the deviating segregation frequencies were mainly due to reduced transmission of the mutant gene through the male gametophyte, probably because the chlorophyll-mutant genes per se affected either the viability of the microspores or the fertilization ability of the pollen grains. (BBB)

49312 EFFECT OF THE ECOLOGICAL ENVIRONMENT ON THE FREQUENCY OF CHROMOSOMAL ABERRATIONS OF γ-IRRADIATED BARLEY. **Nuzhdin, N. I.; Pastushenko-Strelets, N. A. (Inst. of Biological Physics, Moscow). Dokl. Akad. Nauk SSSR, 180: 993-5(June 1, 1968). (In Russian).**

A correlation was established between the radiobiological effect of the γ irradiation of barley seeds and ecological conditions of growth of the plant before and after exposure. The effect was expressed by the varying frequency of chlorophyl mutations and changes in radiosensitivity. The germinating capacity, survival rate, and fertility of plants grown from such grains were studied. The frequency of chromosomal aberrations was determined by cytological experiments. Muscovite 121 type summer barley grains were exposed to 6, 9, and 12 kR of γ radiation from a ^{60}Co source. Although the chromosomal aberrations of the various types were similar, upon exposure to 6 kR the chromosomal aberrations of the Estonian variety increased 10-fold; exposure to 12 kR resulted in a 20-fold increase. On the other hand the Pamir variety was only slightly affected by the irradiation. This result and those of cytological studies indicated that the radiosensitivity of γ-irradiated barley depended not only on the ecological and climatic conditions but also on the growth condition of the parent plants. The larger the differences of ecological conditions before irradiations, the larger would be the differences in the radiosensitivity of the plants grown from the irradiated grains. (TTT)

49313 MODEL STUDIES ON X-RAY MUTATED PLANTS. **Weiling, F. (Univ., Bonn). Biol. Plant., Acad. Sci. Bohemoslov., 8: 175-86(1966). (In German).**

The evaluation of growth conditions in barley plants was studied by means of a model. This required the labeling of specific cells within the total plant tissue. This type of labeling was carried out previously with cell chloroplasts for study of cell polyploidy and cell mutations induced by x irradiation. When initial LII cells were mutated by x irradiation, a definite proportion of the sporogenic mass showed the same type of mutation. This indicated the conditions required and the frequency distribution of mutation and reproduction in the offspring. The basic assumptions made for the model were that the initial samples were stochastically independent of each other, survived according to the law of probability, and mutated by chance. Thus, elimination of the original initials was not needed. The frequency distribution of mutations was more complex in the progeny. The results suggested that there was elimination of cells responsible for the formation of sporogenous masses. (BBB)

49314 THE PROGRESS OF SELECTION FOR QUANTITATIVE TRAITS UNDER DIFFERENT PRESSURES AFTER X IRRADIATION OF SEEDS IN TRITICUM AEST. SSP. VULGARE. **Palenzona, D. L. (Univ., Pavia, Italy). Savremena Poljopr., 14: 255-61(1966).**

Populations of Triticum vulgare were x irradiated with a single dose of 10,000 R. Starting from the R_1 generation, data were collected on four quantitative traits: height of the main stem, number of stems per plant, number of spikelets on the main spike, and number of seeds on the main spike. From the data of the R_2 and R_3 generations an analysis of variance was performed to obtain estimates of the genetic variances. A selection experiment was started at the R_2 and R_3 generations; two selection pressures were applied, 20% and 10%, on progenies of 15 plants each. The selections were performed in two ways, by choosing plus and minus values (disruptive selection), and by choosing values approaching the average of the population (stabilizing selection). The results indicated that selection started at the R_2 generation was more effective than that started at the R_3 for both 20% and 10% pressures. The 20% selection pressure gave better results than 10%, suggesting that the genetic changes were incompletely manifested in both generations considered. (BBB)

49315 PECULIAR ASPECTS OF THE ABERRATIONS OF THE CHROMOSOMES PROVOKED BY THE IONIZING RADIATIONS IN THE CELLS OF ASCITES TUMOURS OF THE MOUSE. Benassi, E.; Piccotti, F.; Cirillo, R. (Univ., Turin). Radiol. Med., 54: 305-14(Apr. 1968). (In Italian).

Chromosome aberrations induced by ionizing radiations in the metaphase of Ehrlich ascites tumor cells are described. Chromosomes were elongated and appeared in the form of irregular, filamentous chains. The percentage of aberrations reached the maximum value 72 hrs after irradiation. (H.L.W.)

49316 EXPERIMENTAL MUTAGENESIS OF FINE FIBER COTTON. Fursov, V. N.; Konoplya, S. P. Khlopkovodstvo, No. 5, 39-42(1967). (In Russian).

Mutants of cotton induced by γ radiation and other mutagens are described. A brief review is given of the mutagenic types of 9123I cotton obtained by γ irradiation with 60 and 50 kR doses and by slow neutron irradiation of 1×10^7 n/cm^2 sec (full activity 950 Ci exposure 0.5 h). (R.V.J.)

49317 EFFECTIVENESS OF DIFFERENT MUTAGENS IN SINGLE AND COMBINED TREATMENTS. Goud, J. V. (Univ. of Agricultural Sciences, Bangalore, India). Genetica, 39: 229-36(1968).

An experiment was made on the effectiveness of combined treatments with some chemical ethyl methanesulfonate (EMS) hydroxylamine (HA) 5-bromo-deoxyuridine (5BDUR) and physical (uv, γ rays) mutagens in inducing visible mutations in hexaploid wheat (Triticum aestivum) variety N. P. 870. Irradiation with γ rays and chemical treatment with EMS produced a high frequency as well as a wide spectrum of mutations. Treatments with uv, HA and 5BDUR gave a very low frequency of mutations. Combined treatments with any of the latter three mutagens reduced the mutation frequency of γ rays alone and of EMS alone. The probable reasons for the reduction of the mutation frequency in combined treatments are discussed. (auth)

49318 TUMOR INDUCTION AS A MEASURE OF GENETIC DAMAGE AND REPAIR IN SOMATIC CELLS OF MICE. Curtis, H. J.; Czernik, Carol; Tilley, John (Brookhaven National Lab., Upton, N. Y.). Radiat. Res., 34: 315-19(1968).

Groups of mice were subjected to x rays and to neutrons, followed either one month or nine months later with a large dose of CCl_4. The animals were sacrificed at 20 months of age, and liver tumors were scored. The CCl_4 treatment unmasks the carcinogenic mutations produced by the radiation. It is found that the tumor incidence is about the same for x rays and neutrons, and that tumor incidence is almost as high when the CCl_4 is given nine months postirradiation as when it is given at one month. This indicates that, once a carcinogenic mutation is formed, repair is impossible. This is especially interesting, since chromosomal aberrations scored in regenerating liver cells indicate a marked long-term recovery following x irradiation but not following neutron irradiation. It is concluded that certain structural repair of chromosomes is possible over protracted periods but repair of functional genetic damage probably is not. (auth)

49319 CYTOGENETICS OF AEDES AEGYPTI. Rai, K. S. (Notre Dame Univ., Ind.). Bull. World Health Organ., 36: 363-5(1967).

The response of A. aegypti chromosomes to irradiation and chemosterilants is reviewed. To study the effects of radiation on the mitotic activity, the number of dividing cells in whole brains of fourth-instar larvae following exposure to x rays (500, 1000, 2000, and 4000 R) were scored. Initially, all doses suppressed mitotic activity almost completely. After a time (depending on the dose used) there was a great increase in cell division, the rate at 500 and 1000 R being more than double the rate in untreated controls. Among the chromosome aberrations induced by x rays in the somatic cells were deletions, exchanges, rings, dicentrics, and anaphase bridges. Certain heritable chromosomal changes such as reciprocal translocations and trisomy were induced in gonial cells. F_1 hybrids of crosses between certain strains of A. aegypti showed marked radioresistance. Furthermore, these hybrids showed a higher rate of mitosis when compared with the parental stocks. Because of this higher rate of cell division, repair of radiation damage was probably more readily effected in the hybrids. (BBB)

49320 CYTOGENETIC INVESTIGATIONS ON NATURAL ANTIMUTAGENIC PROTECTIVE MATERIALS FOR RADIODIAGNOSIS, RADIOTHERAPY, AND OCCUPATIONAL RADIATION BURDENS. Barthelmess, Alfred; Huber, Herbert; Fuerst, Hans (Univ., Munich). Strahlentherapie, 136: No. 1, 116-30(July 1968). (In German).

Substances were selected from the ingredients of natural food, beverages, and spices, as well as from additives used in the food industry, which seemed to be suited as protective substances against cytogenetic x radiation damages. The rates of structural aberrations in chromosomes and of abnormal mitotic times in root tips of Allium cepa (kitchen onion) were used as tests. Thirty-five substances were tested. Vitamin A-palmitate, vitamins E, C, and B_8, glutamic acid, fructose, fumaric acid, maleic acid, sorbic acid, gallic acid, and cinnamic acid seemed to be the most suitable ones for further investigations. The correlations between chemical structure and protection effect are discussed. The assumption that there is no protective effect for exposure under 50 R did not seem to be justified. (auth)

49321 EFFECTS OF GAMMA-RAY FRACTIONATED DOSES ON CHROMOSOME ABERRATION FREQUENCIES. Moutschen-Dahmen, J. Moutschen-Dahmen, M.; Gilot, J. (Univ., Liege). Experientia, 24: 843-4(Aug. 15, 1968).

Dry seeds of Nigella damascena were γ irradiated at 3 krad/min. Exposures to 2 or 4 krad were given in 2 fractions separated by intervals from 1 to 64 min. Root tip chromosome aberrations were counted after germination. A decrease in aberrations was found when the interval between exposures was 4 min or more. An ion bond mechanism is suggested for the repair of chromosome breaks. (C.O.)

49322 THE PRODUCTION OF HAPLOID/DIPLOID CHIMAERAE OF XENOPUS LAEVIS LARVAE BY IRRADIATION. Kassem, Ibtesam Abdel Aziz (Cairo Univ.). Proc. Egypt. Acad. Sci., 20: 19-22(1966-1967).

Haploid/diploid chimeras of Xenopus laevis larvae, produced by uv irradiation of fertilized eggs, grow more rapidly, are less edematic, and have better formed jaws than haploid larvae. In some, eyes and heart are better developed. The presence of diploid tissue increases the viability of haploid larvae. Haploid and diploid cells differ in dimensions, shape of nucleus, and number of nucleoli. The neurocranium is mostly diploid, the viscerocranium mostly haploid. (auth)

Health Physics and Safety

Refer also to abstracts 48852, 48941, 48986, 49026, 49027, 49046, 49089, 49126, 49127, 49134, 49177, 49184, 49228, 49282, 49389, 49390, 49415, 49420, 49440, 49492, 49493, 49551, 49557, 49597, 49642, 49652, 49676–49678, and 50487.

49323 (GAT-R-430) HEALTH AND SAFETY ACTIVITIES REPORT FOR 1967. (Goodyear Atomic Corp., Piketon, Ohio). May 6, 1968. Contract AT(33-2)-1. 49p. Dep. CFSTI.

Health and safety activities during 1967 of the Medical Subdivision and Safety Department at Goodyear Atomic Corporation are described. Some of these activities are those of the atomic energy gaseous diffusion operations; other activities described include those typical of large industrial organizations. Some of the more pertinent health physics statistics are presented in tabular form. (B.S.L.)

49324 (NP-17266) ANNUAL REPORT TO THE DIRECTOR-GENERAL FOR THE YEAR ENDED 30th JUNE 1967. (Commonwealth X-Ray and Radium Lab., Melbourne (Australia)). 28p. Dep.

Activities of the Commonwealth X-Ray and Radium Laboratory in 1967 are described. Sections on establishment of national standards of activity and exposure, care and maintenance of Commonwealth radium and radon supplies, advisory services for medical users of x radiation, procedures for purchasing and distributing radioisotopes, and health physics services are included. (B.S.L.)

49325 (NYO-2740-5) ANNUAL REPORT ON RESEARCH PROJECT. (Columbia Univ., New York. Radiological Research Lab.). Jan. 1, 1968. Contract AT(30-1)-2740. 303p. Dep. CFSTI.

Separate abstracts were prepared on the three sections of this report. They include research in radiological physics, biophysics, and radiobiology. (E.R.B.)

For abstracts of individual sections see: 49284, 49326, and 49485.

49326 (NYO-2740-5, pp 6-200) RADIOLOGICAL PHYSICS. (Columbia Univ., New York. Radiological Research Lab.).

The dosimetry of monoenergetic neutrons was determined for corn embryos and Drosophila, and dosimetry studies were conducted for a fast neutron therapy beam and for the BNL medical research reactor. Measurements of the microscopic distribution of radiation energy were made for a variety of sources using proportional counters. Measurement of the ^{60}Co γ spectrum was made and the local energy density spectra analyzed. The counting

rate of an isotropic source was determined as a function of the distance from a sphere, and a description is given of a miniature X-ray calibration tube. Ancillary studies by the radiological physics group included problems relating to: a low voltage X-ray generator; development of a p-type ionization chamber (tissue-equivalent plastic); mass absorption coefficients from 0.5 to 5 keV; and accelerator facilities for radiological research. (E.R.B.)

49327 (PROT-SAN-01/67) DATA ON ENVIRONMENTAL RADIOACTIVITY COLLECTED IN ITALY, JANUARY–JUNE 1966. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). Mar. 1967. 212p. Dep.

Data are presented on the gross β-radioactivity of the atmosphere at ground level and of fallout deposited on the ground, on the ^{90}Sr and ^{137}Cs content of samples of milk and geographical and irrigation water, and on the ^{137}Cs content of samples of bovine meat. The data were collected during January to June, 1966 at 31 locations throughout Italy and neighboring islands. In most cases, the results are compared graphically with results obtained in previous years. The data are presented in both graphic and tabular form. (E.R.B.)

49328 RADIATION HAZARD AND RADIOLOGY IN THE OPERATING ROOM. Kirsh, I. E. (Veterans Administration Hospital, Hines, Ill.). Ill. Med. J., 130: 790-2(Dec. 1966).

There is no threshold level of radiation which is entirely harmless. A level of radiation for the population as a whole that will increase mutations by only 25% can be tolerated without seriously damaging the collective germ plasm. This amount of radiation is equivalent to an average population dose of 20 R before conception (up to the age of 30 yr). For people occupationally exposed to radiation, this may be 100 mR/week or 5 R/yr, with the precaution that it not exceed 30 R by age 30 yr. Genetic effects are spread widely through the population, rather than being traceable to the immediate descendants of the exposed. Large amounts of irradiation may cause blistering, ulceration, deep fibrosis, and after some delay, leukemia and cancer. Small amounts of radiation also may have harmful effects if administered over a long time. These include leukemia, and probably shortening of life-span. For the anesthesiologist the dose is 10 mR for a single angiocardiogram, 18 mR for cardiac catheterization, and less than 5 mR for a cholangiogram or a hip-pinning operative procedure. Ways to minimize irradiation include: distance, collimation, and shorter and fewer x-ray examinations. (BBB)

49329 RADIATION DOSIMETRY. Smith, Edward M. (Univ. of Miami, Coral Gables, Florida); Brownell, Gordon L.; Ellett, William H. pp 742-84 of Principles of Nuclear Medicine. Wagner, Henry N. Jr. (ed.). Philadelphia, W. B. Saunders Co., 1968.

Calculations of the absorbed dose of radiations are reviewed. The units and international regulations are described. Equations for calculating absorbed dose are presented with the data required for their use. The dose reciprocity theorem and its applications are discussed. Examples are given of the use of the equations for calculation of absorbed dose in various body organs. 51 references. (M.M.B.)

49330 PRINCIPLES OF RADIATION SAFETY. Penner, Ralph (Mercy Hospital, Baltimore). pp 785-94 of Principles of Nuclear Medicine. Wagner, Henry N. Jr. (ed.). Philadelphia, W. B. Saunders Co., 1968.

A protection program for a clinical or research facility for handling radioactivity is outlined that is designed to be adequate and complete, but not unduly restrictive. Types of human-use licenses and training requirements for users are described. The protection program involves shielding, warning signs and labels, monitoring of both personnel and areas, calibration of instruments, proper equipment, testing sealed sources for leakage, safe disposal of radioactive wastes, proper administrative procedures, and records on isotopes, personnel exposure, sources, instruments, wastes disposal, medical examinations of personnel, and accidents. General safety rules should also be observed. (M.M.B.)

49331 PARTICLE SIZE AND ANIMAL AGE AS FACTORS IN EVALUATING HAZARDS FROM INGESTED RADIONUCLIDES. Sikov, M. R.; Mahlum, D. D.; Mahony, T. D.; Sullivan, M. F. (Battelle Memorial Inst., Richland, Wash.). Contract AT(45-1)-1830. Monogr. Nucl. Med. Biol., No. 1, 524-35(Feb. 1968).

From Gastrointestinal Radiation Injury Symposium, Richland, Wash. See CONF-660917.

The behavior and pathological effects of ingested, nonabsorbed radioactive particles in the gastrointestinal tract were studied. Simulated reactor fuel particles (containing ^{89}Sr), ^{106}Ru-Rh, and PuO_2 particles were fed to rats. The feces were monitored and gastrointestinal tracts were examined for gross and microscopic pathology. The larger (1mm dia) simulated fuel particles passed more slowly through the tract than the PuO_2 (1μ dia) particles or the ^{106}Ru-Rh solution. The overall passage time for juvenile rats did not differ markedly from the time for the adults. Since younger rats have shorter tracts it is suggested that exposure to radioactivity may be greater in the infant. (M.M.B.)

49332 SOME ASPECTS OF THE RADIOLOGICAL PROTECTION AND DOSIMETRY OF THE GASTROINTESTINAL TRACT. Dolphin, G. W.; Eve, I. S. (United Kingdom Atomic Energy Authority, Harwell, Eng.). Monogr. Nucl. Med. Biol., No. 1, 465-76(Feb. 1968).

From Gastrointestinal Radiation Injury Symposium, Richland, Wash. See CONF-660917.

The natural incidence of cancer of the human gastrointestinal (GI) tract is reviewed. The sensitivity of the GI tract to radiation is evaluated by comparing the increase in cancer of the tract to the increase in malignant conditions in other body organs of exposed persons. The same radiological protection standards are considered to be valid for the GI tract as for other body organs. Radiation dose calculations for the four sections of the GI tract from ingested radioactive materials are presented. (M.M.B.)

49333 MATHEMATICAL MODEL FOR GI TRACT DOSIMETRY. Vacca, G.; Bazin, J. P.; Karhausen, L. (French Atomic Energy Commission, Fontenay-aux-Roses, France). Monogr. Nucl. Med. Biol., No. 1, 477-84(Feb. 1968).

From Gastrointestinal Radiation Injury Symposium, Richland, Wash. See CONF-660917.

A new method is suggested for determining the dose administered at any point in the gastrointestinal (GI) tract after oral ingestion of radioactive substances. An attempt was made to correlate the dose administered to the wall of the GI tract with the GI content of the contaminated food. An equation was established for calculation of maximum permissible concentration at any level of the GI tract. (M.M.B.)

49334 DOSIMETRIC EVALUATIONS AND HYSTOLOGICAL AND HYSTOENZYMATIC MODIFICATIONS IN RAT KIDNEYS AFTER INJECTING CHLORMERODRIN-^{203}Hg. Blandino, G.; Gallippi, G. B.; Minutoli, A.; Martines, F. (Univ., Messina, Italy). Med. Nucl.-Radiobiol. Lat., 10: 331-47(1967). (In Italian).

Experimental studies were carried out on rat kidneys in order to evaluate possible radiation damage following intravenous injection of ^{203}Hg-chlormerodrin in doses comparable to those used clinically. Autoradiographic, hystological, and hystochemical studies and dosimetric calculations were made on isolated kidneys at various intervals after injection of the isotope. The absorbed dose for β contribution was of 35.4 RAD/μCi. Autoradiograms confirmed that the isotope was mainly in the external cortex of the kidney, although radioactivity traces, probably due to elimination, were found also in the medulla. Slight morphologic and enzymatic alterations were shown. Particularly an increase of some activities of the direct oxydative cycle and glutamic-hydrogenase and to a lesser extent, of cytochrome oxidase, was found. Krebs cycle activity (i.e., isocytric and succinic) was diminished. Hystological and hystoenzymatic modifications appeared particularly in areas showing localization of the isotope. The possible significance of these phenomena is discussed. (auth)

49335 COMMON SOURCES OF RADIATION EXPOSURE. Morgan, Karl Z. (Oak Ridge National Lab., Tenn.). Amer. Eng., 38: 38-42(July 1968).

Many commercial, industrial, medical, research, and consumer product electrical devices, operating mostly in the intermediate voltage range of 10 to 200 kV may produce x rays. Some devices, such as diffraction analyzers and electron microscopes, have been recognized as potentially dangerous x-ray sources for many years, but even today such equipment may lead to overexposures because of improper supervision and failure to recognize conditions under which x rays may leak from these devices. For example, the eyes of the researcher may be overexposed, leading to an increased risk of radiation-induced cataracts. The industrial radiographic x-ray machine is notorious for its use under poor supervision so that operators and other nearby workers are overexposed. Devices such as the high-voltage vacuum switch or the high-voltage vacuum condenser are potentially dangerous x-ray sources. The hazard from color television sets is assessed on the basis of an exposure of 0.5 mR/hr at 5 cm or 3 mRAD/yr at 8 ft and for chronic exposure of this type, about 8×10^{-4} mutations per yr/R would be expected. Under these assumptions, a relatively low figure is obtained of about 70 genetic deaths per yr in the United States at equilibrium. This is not a negligible risk but is extremely low compared to others in the environment. The most important source of population exposure to ionizing radiation is the medical x-ray machine. It is estimated that of man-made sources of ionizing radiation in the United States at present, about

94% of the gonad exposure is received from medical sources, 5% from weapons fallout, and less than 1% from all other sources, some of which are discussed. Surveys have indicated skin doses for chest x rays ranging from 10 to 1000 mR and for dental x-ray series ranging from 300 to 300,000 mR. Yet, doses toward the lower range of the scale may yield better radiograms with more medical information. The extent of the hazard from fallout radionuclides and the hazard to U miners is assessed. By 1967, 89 uranium miners had already died of lung cancer as the result of prolonged Rn and daughter-product exposure, and the projected number based on the past record is 1150 cases of lung cancer by the end of 1985. (BBB)

49336 BLOOD ^{137}Cs PROJECT, 1967. Yamagata, N. (Inst. of Public Health, Tokyo). Health Phys., 15: 276-80(Sept. 1968).

A method of blood analysis was proposed as a means of obtaining worldwide information on internal irradiation due to fallout ^{137}Cs (Yamagata, Assessment of Radioactivity in Man, Vol. 2, p. 41 (1964), International Atomic Energy Agency, Vienna). Principles of the method, and the method of assessment of Q values (^{137}Cs/K ratios) on the basis of blood concentration of ^{137}Cs, are described by the author in Health Phys., 12: 901(1966). Data from several countries in the Far East and the Pacific Region were reported in Nature 213: 1152(1967). In 1967 the project was enlarged to involve other parts of the world, and particularly Africa and South America, and results obtained are reported. Some discrepancies could be explained as a consequence of the extensive redistribution of marketed foodstuffs between countries, and probably also some ecological factors. (UK)

49337 CLINICAL STUDIES ON WHOLE-BODY POTASSIUM CONTENT MEASURED BY GAMMA-RAY SPECTROMETRY IN HEALTH AND DISEASE. Hughes, D.; Williams, R. E.; Smith, A. H. (Univ. of Leeds, Eng.). Clin. Sci., 32: 503-9(June 1967).

The whole-body K of normal subjects was measured using a plastic scintillator whole-body radioactivity counter. The values for the K contents were calculated using a calibration formula based on consideration of the self-absorption by the body of the γ radiation from the ^{40}K in terms of the weight and height of the subject. Total-body water was determined by the dilution of 300 μCi of tritiated water given intravenously. Regression equations were established for whole-body K on total body water and on body weight from data for 22 normal male subjects on a normal fluid intake and diet. Results showed that the whole-body radioactivity counter provided a convenient tool for the measurement of whole-body K. It permitted frequent serial measurements and, by using appropriate calibration techniques, no radioactive tracer, with its concomitant radiation dose, needed to be administered. The measurement on the patient was rapid, and it took only about 16 min to obtain adequate statistical accuracy in the counts recorded. The result was calculated almost immediately with a standard error of ±4.7% for a K content. The regressions of whole-body K on gross body weight (equation 1) and on total body water (equation 2) were both very highly significant ($P < 0.001$) but the latter had a slightly better correlation. (BBB)

49338 $(MPC)_a$ FOR ^{13}N. Kase, K. R. (Univ. of California, Livermore). Health Phys., 15: 283(Sept. 1968).

Reference is made to the calculation given by the author in Health Phys. 13: 869 (1967). Subsequently it was suggested that since that calculation is based on immersion in an infinite sphere the value of $(MPC)_a$ obtained may not be a strictly valid maximum air concentration for the case of gas contained in the situations discussed. This suggestion is further discussed in the present communication. It is realized that the value would vary with room size, and it would be about 3.0×10^{-4} μCi/cc for a 1000 m^3 room; but the energetic positron radiation from ^{13}N becomes limiting for the calculation. The positron range in air is <2m and hence the infinite hemispherical cloud calculation is appropriate with E = 0.4 MeV/dis. The most appropriate $(MPC)_a$ for ^{13}N in this case is 2×10^{-5} μCi/cc. (UK)

49339 CONTAMINATION BY A ^{210}Po RADIATION SOURCE. Vaupel, Fr. Zentralbl. Arbeitsmed. Arbeitschutz, 17: 203-6 (July 1967). (In German).

An accident case is described in order to illustrate the degree of contamination that may be caused by unsealed radioactive sources, and how decontamination may best be undertaken in such circumstances. The contamination levels caused by a ^{210}Po source are listed in a table. Precautions for preventing such accidents are suggested. (Occup. Safety and Health Abstr.). (CIS)

49340 "ISKRA-1" DEVICE IN MEDICO-BIOLOGICAL INVESTIGATIONS. Kalina, V. K.; Pauk, S. M.; Tishchenko, F. M. (Kiev Graduate Medical School). Med. Radiol., 13: No. 8, 65-8 (Aug. 1968). (In Russian).

Iskra-1 conversion decade unit, devised by the All-Union Scientific-Research Institute of medical instruments and equipment and now put on a serial production line, may be employed for registration of the radiation activity levels in biological materials (blood, urine, saliva, etc.), and also for analyzing specimens of water, foodstuffs, etc., if a well-type scintillation detector is connected thereto. Operation of the well-type detector, however, demands a high-voltage current supply of the order of 1800 V, this not being provided for in conversion scheme of the Iskra-1 device. It is suggested that the power supply of the well-type detector be realized through a high-voltage stabilized rectifier, Model BCB-2, with the signal coming from the well-type detector recorded by the conversion unit. The foregoing investigations demonstrate this combination to be highly effective, allowing at the same time the amount of the isotope introduced into the organism to be cut down to a fraction of its former value. (auth)

49341 LIST OF SUPPLIERS OF PROTECTIVE EQUIPMENT. III. PERSONAL PROTECTION: BODY. I. BODY PROTECTION. II. OTHER PERSONAL PROTECTIVE EQUIPMENT. Edition INS No. 319C. Paris, Institut National de Securite, 1967. 16p. (In French).

Particulars of French suppliers of personal body protective equipment are provided under the following headings: protective clothing manufactured from cloth, fireproof material, leather, rubber, plastics, impregnated or synthetic material, glass or asbestos fibre, or metallised heat-protective materials; vortex tube for air cooling; self-contained cool air circulation appliances; metallised asbestos or cottom materials; clothing for work in cold temperatures; heated jackets and soles; gas and dust protective clothing; impregnating agents; x ray protective aprons and screens; butchers' aprons; metal mesh clothing; metallic materials; jackets, vests and aprons for use in mines and civil engineering works; fluorescent clothing; clothing and accessories for cyclists and pedestrians; reflecting materials; safety belts for work at heights and motor vehicle drivers; fall arresting and preventing devices; and body support equipment for truck drivers. (Occup. Safety and Health Abstr.) (CIS)

49342 THE MEDICAL SERVICE OF THE PLUTONIUM PRODUCTION CENTER OF MARCOULE. Presse Med., 75: 2199-2200(Oct. 21, 1967). (In French).

The protection of workers against radiation at the Commissariat a l'Energie Atomique Centre de Marcoule is discussed. Innovations in construction were required to provide for safety according to French statutes as well as standards imposed by Euratom regarding workers exposed to radiation. The ground floor of the building contains facilities for decontamination, consultation rooms, laboratories, social services, and radiodiagnostic and photographic units. The other building contains a section for decontamination, and another section for γ spectrometry. Strict surveillance is maintained over all contacts, accidental or necessary, with radioelements, and decontamination is monitored. Radiation exposures of about 2400 persons are monitored. All contamination incidents are carefully followed and a dossier maintained on each worker. Ophthalmologic, otorhinolaryngologic, and various other examinations are made periodically (50,000 hemotologic examinations were made in 7 yr). Studies of those persons exposed to radiation, slightly exposed, and not exposed showed almost no difference in leukocyte counts. It has been established at the Centre that polymorphonuclear leukocyte counts of 42 to 70% are normal for healthy persons. Measures are also taken to protect workers against internal irradiation caused by internal contamination, to follow excretion of radionuclides, and to perform whole-body counts on personnel. (BBB)

49343 DEMONSTRATION OF PLUTONIUM INCORPORATION BY DIRECT MEASUREMENT. Kiefer, H.; Maushart, R. (Gesellschaft fuer Kernforschung mbH, Karlsruhe, Ger.). Atompraxis, 14: 338-44(Aug. 1968). (In German).

The present possibilities for demonstrating the incorporation of Pu by direct measurement are surveyed. Measurement techniques, limits of demonstrability, and influence of errors are discussed, both for in vivo measurement of inhaled ^{239}Pu and for demonstration of its presence in wounds. The present state of detector development is discussed in particular detail, and the setup in operation at the Nuclear Research Center in Karlsruhe for direct measurement of ^{239}Pu in the lung is closely described. (auth)

49344 NEW POINTS OF VIEW ON ISODOSE CONFIGURATION IN CONTACT IRRADIATION OF VOCAL CORD CARCINOMA WITH RADIOACTIVE SUBSTANCES. Minnigerode, B.; Grohmann, R. (Univ., Goettingen, Ger.). Arch. Klin. Exp. Ohren-, Nasen-Kehlkopfheilk., 186: 365-72(1966). (In German).

Mathematical formulae for the isodose patterns of the linear and spatial energy distribution of contact irradiation treatment of vocal cord carcinoma, using various source conditions were calculated. The isodoses were formed so that they intersected the anterior and posterior ends of the vocal cords, were least along the edges, and had a low dose gradient along the vocal cord. The mathematically and physically determined spatial distribution required to deliver the dose necessary was estimated for each localization area of vocal cord carcinoma and for various source intensities. The effects of modification of the symmetrical or unsymmetrical placement of irradiation sources of smaller size or various γ activities in the carrier were studied. The mathematical formulae developed permitted the irradiation intensity at all points within the field to be calculated exactly. (BBB)

49345 CALCULATION OF COMPENSATING FILTERS FOR THE FORMATION OF THE DOSE FIELD IN MULTIFIELD TELEIRRADIATION. Sinitsyn, R. V. (Leningrad Central Scientific-Research Inst. of Roentgen-Radiology). Med. Radiol., 13: No. 8, 58-65(Aug. 1968). (In Russian).

The theory of calculating compensating filters for the control of distribution of depth doses in multifield teleirradiation (bremsstrahlung and radiation) is discussed. The method of calculation enables the assessment of changes of the dose, associated with the curvature of the irradiation surface, the influence on the distribution of depth doses of differences in the density of soft tissues, lungs, and bone, as well as of the heterogeneity, associated with the summation of diverse doses from irradiation fields falling on the target at an angle. A mathematical method of linear programming is used in the technique. It also could be used in the calculation of filters for combined methods of radiation treatment using teleirradiation in combination with intratissular and intracavitary. An example is given for a case of three-field irradiation of esophageal cancer using linear accelerator with an energy of 4.3 MeV. (auth)

49346 MEASUREMENT OF THE ACTIVITY RELEASED VIA THE EXHAUST AIR WITH THE HELP OF DOSIMETERS. Guenther, G.; Koenig, L. A. (Kernforschungszentrums, Karlsruhe, Ger.). Atompraxis, 14: 344-6(Aug. 1968). (In German).

A simple method for assessing the activity released via an exhaust stack and based on the measurement of the γ-dose and of the quantity of the exhause air is described. The dosimeters used for this purpose must have the lowest possible fading and, therefore, glass dosimeters were employed. A cylindrical geometry was taken as an example to calculate the correlation existing between the dose rate and the activity concentration. The result agreed well with the respective measurements. Besides, a correlation was given by a formula between the dose and the activity passing through the stack. The quoted formulae include besides the geometry of the facility the average speed of the exhaust air and the quantity of exhaust air respectively, as well as the composition of the radioactive gases passing through the stack. The accuracy of information obtained by this method is limited by the variations in the quantities of exhaust air with respect to time and, possibly, by the composition of the exhaust gases. Moreover, nuclides which do not emit γ-rays are not measured. In spite of these limitations, the method seems to be useful as an additional monitoring provision, the more, since the means required for its implementation are very modest. (auth)

49347 DOSIMETRY WITHIN THE BODY OF RATS AFTER ^{90}Sr–^{90}Y-INCORPORATION. Steinbach, K. H.; Kriegel, H. (Heiligenberg-Institut, Ger.). Atompraxis, 14: 336-8(Aug. 1968). (In German).

The dose of ^{90}Sr–^{90}Y radiation delivered to the liver of rats was measured at different intervals after an intravenous injection of ^{90}Sr–^{90}Y by means of LiF-dosimeters. Simultaneously the concentrations of ^{90}Sr and ^{90}Y activity contained in the liver of these animals were measured and the radiation dose calculated and compared with the values obtained by LiF-dosimeters. When the radioactivity injected was 40 μCi, the dose delivered to the liver after 16 days was 165 rad. The deviation of the dose calculated from dose measured was less than ± 10%. (auth)

49348 PERSONNEL NEUTRON DOSIMETRY BY NUCLEAR TRACK REGISTRATION IN SOLID MATERIALS. Becker, K. (Kernforschungsanlage, Juelich, Ger.). Atompraxis, 14: 331-6(Aug. 1968). (In German).

The method of non-photographic nuclear track imaging by chemical etching of the surface of insulators can be used for thermal and fast neutron dosimetry by (n,f) reactions (registration of fission fragments emitted by foils of fissile materials in glasses, mica, and plastics), further (n,α) reactions (alpha particle registration in sensitive plastic foils), and/or registration of recoil nuclei in plastics. Neutron energy distributions can be measured by threshold reactions and/or the use of additional neutron absorbers. The method is superior to conventional nuclear emulsion and activation techniques in many respects, such as sensitivity, dose range, directional dependence, insensitivity against X, gamma and beta radiation and disturbing environmental influences, fading stability, fast and simple evaluation, etc. The visual etch pit counting in the optical microscope can be avoided by several optical or electrical automatic techniques. Some aspects of the practical application of the method in routine and emergency neutron dosimetry, such as the choice of proper materials and etching, conditions, as well as some limitations and research goals are briefly discussed. (auth)

49349 ECCENTRIC PENDULUM MOVEMENT IN TELECOBALT THERAPY: STUDY OF THE RELATIVE DOSE DISTRIBUTION BY MEANS OF ELECTRONIC METHOD OF CALCULATION. Renzi, R.; Maurenzig, P. R. (Univ., Florence). Nunt. Radiol., 33: 233-48(Mar. 1967). (In Italian).

The difficulties encountered in calculations of the distribution of the dose from a ^{60}Co γ source when pendulum techniques are used for therapy are discussed. A method is described that uses an IBM 7090 computer for calculation of the dose distribution based on data obtained from measurements made in a water phantom. (C.H.)

49350 DOSIMETRY WITH FILMS AND CRITICALITY DOSIMETERS. Boulenger, R.; Ghoos, L. (CEN, Mol, Belg.). J. Belge Radiol., 51: I-XIII(1968). (In French).

The nature and the energy of the incident radiations must be determined in order to know the dose at the critical organs. The principles involved in the use of the photographic emulsion as dosimeters are reviewed. Construction and characteristics of the C.E.N. film dosimeter are discussed. The dose can be determined for thermal neutrons, β rays (0.76 to 3.5 MeV), and photons (γ and x of 12 keV to 1.3 MeV). The holders which are made of Al, Cd, lucite and polypropylene can be used as dosimeters in the event of a criticality accident. (auth) (TSS)

49351 PHOTOGRAPHIC RADIATION DOSIMETRY WITH THE ATOMIC ENERGY RESEARCH ESTABLISHMENT-RADIOLOGICAL PROTECTION SERVICE FILM DOSIMETER. Segaert, O. (Rijksuniversiteit, Ghent). J. Belge Radiol., 51: XIV-XVIII(1968). (In French).

A film dosimeter using a single photographic film and six filters of various materials is described. With this dosimeter it is possible to distinguish between doses produced by β radiation up to 4 MeV, by x and γ radiation from 15 keV to 2.5 MeV, and by thermal neutrons. The range of measurements spreads from 10 mrad to 40 rad for x rays, from 10 mrad to 1,000 rad for γ radiation, from 10 mrad to 2,000 rad for β radiation, and from 5 to 10 mrem to 800 rem for thermal neutrons. (auth)

49352 EFFECTIVENESS OF COLLECTION OF IONS IN DOSIMETRY OF IMPULSE RADIATION. Mil'shtein, R. S. (Moscow Scientific-Research Inst. of Roentgen-Radiology). Med. Radiol., No. 9, 82-5(1968). (In Russian).

The effectiveness of ionization chambers filled with various gases was compared for the collection of ions of impulse radiation (γ and x 50 imp/sec, with the duration of the impulse 10 microsec). For mean doses up to 100 rad/min the effectiveness of ion collection in all dosimeters was close to 100 per cent. For higher doses, up to 1000 rad/min, only one type of chamber was effective. The values of the given parameter are presented for all ionization chambers tested. (auth) (TSS)

49353 AUTOMATIC DOSIMETER FOR PHOTOGRAPHIC DOSIMETRY. Belletti, S.; Zaglio, E. (Spedali Civili, Brescia, Italy). Radiol. Med., 54: 366-76(Apr. 1968). (In Italian).

An apparatus for automatically constructing isodose curves by a photodensitometric method is described. The readings of density values on a linear scale are given by photoresistance and a logarithmic amplifier. The exploration of films is made by a scanning system with intervals from 4 to 22 mm. The system may also be used for the semiautomatic reading of film badges according to the filtration system adopted at the Istituto del Radio of Brescia. (H.L.W.)

49354 GUIDE FOR USE OF THE RADIOISOTOPE LABORATORY, RESEARCH INSTITUTE FOR NUCLEAR MEDICINE AND BIOLOGY, HIROSHIMA UNIVERSITY. Takeshita, Kenji; Antoku, Shigetoshi (Hiroshima Univ.). Proc. Res. Inst. Nucl. Med. Biol., No. 9, 43-9(May 1968). (In Japanese).

The fundamental structure and protection facilities of the radioisotope laboratory in the institute are described. In order to prevent radiation damage and to use effectively within a limited period of time, users should have thorough knowledge of the regulations and the capacity of equipments for storage, draining, and ventilation. (auth)

49355 MEDICAL RESEARCH COUNCIL ANNUAL REPORT (UK), APRIL 1967 TO MARCH 1968. London, Her Majesty's Stationery Office, 1968. 356p. 31s.

A brief summary is presented of research carried out by the Radiobiological Research Unit (Harwell), the Experimental Radiopathology Research Unit (Hammersmith Hospital, London), the Environmental Radiation Research Unit (General Infirmary, Leeds), the Radiological Protection Service (Sutton, Surrey), and the Cyclotron Unit (Hammersmith Hospital, London). (UK)

49356 CALCULATION OF DEPTH DOSES OF LONG-WAVE ROENTGEN RADIATION. Bronshtein, I. E.; Krisyuk, E. M. Med. Radiol., 13: No. 3, 36-41(1968). (In Russian).

The article describes a method of calculating depth doses of soft roentgen radiation, experimental determination of which presents great difficulties. The method is connected with calculation of the spectrum of roentgen tube radiation after Wenzel's formula. The described method of calculating depth and absorbed doses may be utilized in x ray therapy for evaluating the doses absorbed in the irradiated tissue and integral absorbed doses, as well as in radiobiological experiments. (auth)

49357 APPLICATION OF THE PHOTOGRAPHIC METHOD FOR ANALYSIS OF THE DOSE DISTRIBUTION IN THE MOST SUPERFICIAL LAYERS WITH HIGH-ENERGY RADIOTHERAPY. Cavallo, V. (Univ., Rome). Nunt. Radiol., 33: 125-41(Feb. 1967). (In Italian).

The shape of the build-up curve and the values of dose absorbed in the most superficial tissue layers by high energy radiations were studied by the photographic method in relation to the area of the field, the focal distance, and the type of the irradiation apparatus employed. Comparison of data using ^{60}Co γ and x from 15 MeV betatron sources led to the conclusion that the larger the area of the field and the less distance between collimator and irradiated object, the higher the superficial dose. (auth) (TSS)

49358 EVALUATION OF THE LEVEL OF OCCUPATIONAL IRRADIATION AMONG MEDICAL WORKERS. Korenkov, I. P.; Moiseitsev, P. I. Med. Radiol., 13: No. 3, 71-3(1968). (In Russian).

Comparative data are given on the irradiation levels among medical and auxiliary personnel during x ray investigations, telegammatherapy, intracavitary and intratissular treatment with the aid of closed radiation sources, as well as treatment involving the use of liquid radioactive preparations and other radiological studies. (auth)

49359 SENSITIVITY OF THE MODIFIED "FERRO-FERRI-SULFATE" DOSIMETRIC SYSTEM. Vakhlakova, T. V.; Ryabukhin, Yu. S. (Inst. of Medical Radiology, Erevan). Med. Radiol., 13: No. 3, 64-6(1968). (In Russian).

In order to make the ferro-ferri-sulfate system more sensitive and precise it was suggested that ferri-ions should be solubilized into the thiocyanate complex and optic density of this complex solution be measured in the visible region of the spectrum. In addition, the upper limit (500 rads) for application of the modified "ferro-ferri-sulfate" system is defined. (auth)

49360 PLANAR DOSIMETRY IN INTERSTITIAL RADIOTHERAPY WITH ^{198}Au. Bompiani, C.; De Maio, G. P.; Ficari, A. (Univ., Rome). Nunt. Radiol., 33: 109-23(Feb. 1967). (In Italian).

Problems involved in measurements of the radiation dose to tissues from ^{198}Au seeds used for interstitial therapy of neoplasms are discussed. Tables are presented for calculating the dose from ^{198}Au seeds of 5 and 10 mCi activity. (C.H.)

49361 COMPARATIVE CHARACTERISTICS OF TECHNIQUES OF RADIOMETRY OF SMALL ACTIVITIES IN BIOTESTS AND IN HUMANS. Malykhin, V. M.; Shaks, A. I. (Leningrad Scientific-Research Inst. of Radiation Protection). Med. Radiol., 13: No. 3, 42-7(1968). (In Russian).

The possibility of an unified approach to the assessment of the actual sensitivity of radiometric techniques of small activities in biotests and in the human organism is discussed. The authors present schedules indicating the direction of changes in the effectiveness and background of optimal measurements from the viewpoint of accuracy. On the basis of the quality parameter, the technique of assessing minimal detected levels of activity in biotests is discussed. (auth)

49362 THREE TASKS OF LINEAR PROGRAMMING IN DOSIMETRIC PLANNING OF RADIATION THERAPY. Sinitsyn, R. V. (Central Scientific-Research Inst. of Roentgen-Radiology, Moscow). Med. Radiol., 13: No. 3, 29-36(1968). (In Russian).

The author discusses three tasks of choosing optimal conditions of irradiation, based on mathematical methods of linear programming. The possibility and expediency of using each one of them is determined by the character of requirements to the configuration of the dose field, as well as the presence of information on tissue tolerance to radiation doses. (auth)

49363 INCREASE OF THE EFFECT OF SCREENING OF AN AREA OF THE BONE MARROW IN IRRADIATION OF ANIMALS. Strelin, G. S.; Pushnitsina, A. D.; Sil'chenko, N. N.; Shmidt, N. K.; Shust, V. F. (Central Scientific-Research Inst. of Roentgen-Radiology, Moscow). Med. Radiol., 13: No. 4, 69-74(1968). (In Russian).

Experiments on albino rats demonstrated that the use of blood loss as a stimulator of hematopoiesis in totally x irradiated (lethal dose) animals does not increase their survival. At the same time such hematopoietic stimulation in animals in which a part of the bone marrow was screened during irradiation exerts a positive effect, intensifying the protective action of the screen. A supposition is made that the effect is due to widening of the area of hematopoiesis both at the expense of a more energetic outcome of trunk cells from the protected area of the hematopoietic tissue and, possibly, at the expense of a more successful "take" and differentiation in the affected part of the organism. (auth)

49364 PROTECTIVE APPLIANCES USED DURING INTERSTITIAL RADIOTHERAPY OF CANCER OF THE MOUTH. Lecacheux, B.; Grellet, J. (Centre Anti-Cancereux, Caen, France). Rev. Fr. Odonto-stomatol., 13: 1423-30(Oct. 1966). (In French).

The side effects in healthy tissue after irradiation in the treatment of mouth cancer were discussed. Two methods of protection were presented: use of a protective shield and keeping the source at a great enough distance from the healthy tissue to diminish radiation effects. Because of the high-energy γ radiation of Ra, requiring excessive thicknesses of lead shielding, ^{192}Ir was used. Different prosthetic techniques for keeping Ra sources at an adequate distance are described in detail. The use of ^{192}Ir in the form of a wire in an afterloading technique reduced the exposure to operating personnel as well as making protection of the patient easier. Construction and application of prosthetic devices containing radiation sources for treatment of mouth tumors were described and illustrated. (BBB)

49365 CALCULATED LET DISTRIBUTIONS OF FAST NEUTRONS. Bewley, D. K. (Hammersmith Hospital, London). Radiat. Res., 34: 437-45(1968).

Distributions of stopping power (LET_∞) were calculated for four beams of fast neutrons: neutrons of 14.6 MeV, neutrons produced by bombarding a thick beryllium target with 15-MeV deuterons, neutrons of 3 MeV, and fast neutrons produced by bombardment of a ^{235}U converter plate with thermal neutrons. The track average LET was correlated with mean neutron energy, but the dose average was approximately constant. Neither average was expected to be a satisfactory description of the effects of these neutron beams on mammalian cells. (auth)

49366 DESCRIPTION OF RADIATION FIELDS BY SEPARATION OF PRIMARY AND SCATTERED RADIATION. III. THE TISSUE-AIR RATIO AND THE DEPTH DOSE DISTRIBUTION FOR GAMMA AND X RADIATION IN THE REGION FROM 0.6 TO 42 MeV. Schoknecht, Guenter (Auguste-Viktoria-Krankenhauses, Berlin). Strahlentherapie, 136: No. 1, 24-32(July 1968). (In German).

Based on experimental and published values, a mathematical expression of the tissue–air ratio can be derived for ^{60}Co beams. Beside the build-up for electron equivalency a build-up for scattered photons can be identified. The equation can be applied without modification for x- and γ radiation between 0.6 and 42 MeV. The necessary parameters for the commonly utilized beams (isotope sources, Van de Graaff and linear accelerators, and betatrons) are tabulated. With this expression on tissue-air ratio, the course of depth dose and percent depth dose can be calculated. For every equation the computer program is outlined, allowing calculation for different geometrical circumstances. The equations are also the basis of calculation with the decrement line systems, for planning of irradiations with static and rotation therapy with high-energy photons. (auth)

49367 ^{90}Sr AND ^{137}Cs LEVELS IN THE MILKS OF SOME ARCTIC SPECIES. Baker, B. E.; Lauer, B. H.; Samuels, E. R. (Macdonald Coll., Quebec. Dept. of National Health and Welfare, Ottawa). J. Dairy Sci., 51: 1508-10(Sept. 1968).

Strontium-90 and ^{137}Cs were determined in the milks of the following Arctic mammals: Rocky Mountain bighorn sheep, mountain goat, caribou, husky, beluga whale, fin whale, polar bear, and human (Eskimo). The ^{90}Sr values ranged between 89.8 pCi/g ash for caribou milk to 0.1 pCi/g ash for fin whale milk. The ^{137}Cs concentrations ranged between 510.9 pCi/g ash for the milk of

inland Eskimos to 0.9 pCi/g ash for the milk of mountain goat. (auth)

49368 PREVENTING MORTALITY FROM RADIATION SICKNESS IN RATS BY SCREENING A PORTION OF BONE MARROW DURING IRRADIATION. Gronskaya, N. F. (Central Scientific Research Roentgenology-Radiology Inst., Leningrad). Byull. Eksp. Biol. Med., No. 1, 27-30(1967). (In Russian).

The effect of screening bone marrow as a function of the amount of bone marrow screened and the size of the radiation dose (800, 720 and 650 R) was measured. The screening variants were: both hips and both shoulders, both hips and one shoulder, both hips, one hip, and $\frac{1}{2}$ and $\frac{1}{10}$ of one hip. Even maximum screening (four extremities) was ineffective with a dose of 800 R. With a dose of 720 R maximum effect was achieved by screening both hips, and a further increase in screening showed little additional effect. At 650 R (some control animals surviving) it was found that a therapeutic effect could be achieved with a smaller screening area than with lethal doses. The author concludes from this result that homotransplantation of bone marrow from screened portions under these conditions of irradiation ought to be effective even if the amount of unirradiated bone marrow remaining in the organism is relatively small. (JPRS)

49369 SHIELDING OF FAST NEUTRONS BY NORMAL CONCRETE. Sauermann, P. F.; Schaefer, W. (Kernforschungsanlage, Juelich, Ger.). Atompraxis, 14: 2p.(July 1968). (In German).

The attenuation of fast neutrons in normal concrete was measured for nine neutron energies between 140 keV and 14.2 MeV with the Rem counter of Anderson and Braun and for 14.2 MeV with the recoil proton counter of Dennis and Loosemore. The dose-exposure attenuation coefficient as well as linear expansion was calculated from the slope of the attenuation curve. (tr-auth)

49370 METHODS FOR MEASURING INFRARED RADIATION OF HUMAN SKIN. Petrov, Yu. L.; Kolodchenko, V. P.; Golosnii, V. I.; Zaika, Zh. I. Fiziol. Zh., Akad. Nauk Ukr. RSR, 14: 569-72(July-Sept. 1968). (In Ukrainian).

Proposed methods of measuring infrared (IR) radiation effects on human skin produced good results. Data showed that the sensitivity to irradiation in active skin points was higher than in inactive skin points. Increased activities of the digestive organs (stomach, liver, intestines) after eating were used as indicators of IR-radiation effects on the active points of skin of the abdomen. (R.V.J.)

49371 RADIATION PROTECTION IN INDUSTRIAL MEDICINE. Yoshizawa, Yasuo (Tokyo Univ.). Nippon Ishikai Zasshi, 55: 1307-18(May 1, 1966). (In Japanese).

Radioprotective practices in industry are reviewed in relation to the increasing use of radiation sources and exposure of workers. Two types of radiation exposure of the human body are considered: external irradiation, e.g., from x rays and ^{60}Co γ rays, and exposure from the absorption of radioactive substance by the body. For protection from external irradiation, three principles should be followed: time (keep the exposure time as short as possible); shield (place a radio-opaque barrier between the radiation source and the body); and distance (keep the distance between the radiation source and the subject as large as possible). For protection from the internal exposure from radioactive material, several rules should be observed: dilution, dispersion, decontamination, containment of the radiation source within a localized area, and concentration on radiation control measures. Several direct and indirect methods for the measurement of radioactivity inside of the body are considered. (TSS) (BBB)

49372 MEASUREMENT UNITS USED IN IONIZING RADIATION DOSIMETRY AND RADIATION SAFETY EQUIPMENT. Keirim-Markus, I. B.; Kochetkov, O. A.; Moskalev, Yu. I.; Popov, V. I. Izmer. Tekh., No. 11, 18-19(1966). (In Russian).

The GOST (All-Union State Standard) 8848-63, adopted July 1, 1964, that established joules/kg and coulombs/kg as standard units for measurement of ionizing radiation, absorbed dose, and exposure, respectively is evaluated. In so doing, this GOST standard ignored the decision of the ICRU (International Commission on Radiological Units) to recommend the use of the Rad (= 1 centijoule/kg) and roentgen (= 0.257976 millicoulomb/kg), that are the units in which almost all presently used instrumentation is calibrated and almost all current research expressed. The cumbersome numerical data conversions required by use of the GOST units will afflict not only all studies involving absorbed doses expressed in Rads and exposures in roentgens, but also all biological shielding calculations containing equivalent or effective dose units (ber, Rem) based on Rad and roentgen. Indeed, GOST 8848-63 provides no units whatever for the measurement of dose equivalents. The authors propose that GOST 8848-63 be revised to establish the generally used and ICRU-recommended units of Rad, roentgen, and ber as standard units, and further suggest that any new units for radiological measurement should not be officially adopted by individual countries unilaterally, but proposed through and approved by the ICRU. (ATD)

49373 CURRENT CONCEPTS ON THE USE OF X-RAYS IN DENTISTRY. Wuehrmann, A. H. Ala. J. Med. Sci., 5: 89-97(Jan. 1968).

The contribution of dental radiography to the population radiation exposure and the present state of dental radiation hygiene are evaluated. In the author's practice about 5 R, in air at the skin, is required to produce a 21-film complete mouth radiographic survey. Exposure factors most commonly used are 70 kVp, 10 ma, and 2.25 mm Al total filtration. Class D film is used. The average dose, in air at skin, per film is 0.24 R. Taking into consideration the fact that about 40% of American dentists use film requiring 4 times this exposure, and 15% are using a less than minimally filtered beams, so that a skin exposure must be increased by a factor of 2. This results in a 137.65 mR/yr population skin exposure, excluding backscatter. This does not take into consideration the faulty beam collimation still apparently existing in about 15% of dental offices. The average person in the population is exposed to 137.65 + 50 or 2.8 R/yr of specific area radiation. A complete mouth roentgenographic survey with 21 films results in a total exposure of 5 R, and under optimum conditions, 0.5 mR or less reaches the male gonads. The dose to the female reproductive organs is $\frac{1}{3}$ this amount. Dentistry's annual contribution to the average male's gonadal dose in this country appears to be 0.072 mR. The average male gonadal dose of those actually subjected to x radiation is about 0.28 mR/yr. Any individual can be exposed to a considerably greater gonadal dose. These estimates are compared with the approximate 0.35 mR received each day from natural sources. (BBB)

49374 AUTOMATIC RADIATION ALARM FOR HOSPITAL ROOMS. MacDonald, J. C. F.; Vaart, A. (Victoria Hospital, London, Can.). Brit. J. Radiol., 41: 636-7(Aug. 1968).

The design of an automatic radiation alarm system for hospital rooms is described. The system consists of a radiation detector installed in the ceiling directly above the bed of patients undergoing radiotherapy using sealed sources of radium or other radioactive material. When the radiation detector is activated a warning panel in the corridor wall beside the entrance door is illuminated. This serves as a reminder to medical personnel and also discourages visitors. (C.H.)

Medicine

Refer also to abstracts 49006, 49039, 49083, 49149, 49183, 49185, 49215, 49232, 49237, 49275, 49320, 49345, 49349, 49355, 49360, 49364, 49366, 49494, 49532, 49542, 49546, 49547, 49550, 49559, 49562, 49566, 49580, 49593, 49598, 49599, 49603, 49616, and 49668.

49375 (BNL-12409) USE OF ^{252}Cf AS AN INTERSTITIAL SOURCE OF FAST NEUTRONS. Atkins, Harold L. (Brookhaven National Lab., Upton, N. Y.). [1967]. 18p. (CONF-680420-1). Dep. CFSTI.

From Meeting of the Transplutonium Program Committee, Germantown, Md.

Unlike γ rays and x rays, the biological action of neutrons is virtually independent of oxygen. Since anoxia is a major cause of failure in cancer radiotherapy, there appears to be some advantage to the use of neutrons. The low penetration of neutrons in tissue in comparison to that of high-voltage x rays or ^{60}Co γ rays makes implantation of neutron sources within and around tumors appropriate. Californium-252 has been fabricated in the form of needles. It has a half-life of 2.6 yrs and 1 μg of ^{252}Cf is equivalent to 1 mg of radium. Use of ^{252}Cf for interstitial radiotherapy would combine the advantages of low-intensity irradiation (as with radium) with the advantages of high LET radiation. These advantages are being verified presently using cultured human tumor cells. (E.R.B.)

49376 (CEA-R-3412) ETUDE RADIOBIOLOGIQUE DE L'ACTIVITE RADIOPROTECTRICE D'UN COMPOSE NATUREL IRANIEN: LE "SHIR-KHECHT". (Radiobiological Study of the Radioprotective Activity of a Natural Iranian Compound, "SHIR-KHECHT". Rouhanizadeh, Nasser (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). 1968. 82p. (In French). Dep.

Thesis. Submitted to Univ. of Paris, France.

The primary mechanisms of the action of ionizing radiation

on biological systems, the possible mechanisms of the action of radioprotective substances, the various chemical structures having a protective effect, and methods for studying chemical radioprotection are reviewed. Results are reported from studies on the radioprotective effects of a natural botanical product, Shir-Kecht, following ingestion by lethally and sublethally γ-irradiated rats. Examination of survival curves and histological data showed a marked radioprotective effect of the compound, which is prepared from the viscous globules secreted by the stems of plants such as Cotoneaster mummularia, Atraphaxis spinosa, and Arbutus. The compound is widely used in Iran as a laxative and purgative and is employed in the treatment of a number of febrile conditions, including measles, typhoid, and chronic bronchitis. (C.H.)

49377 (CONF-660839) LABORATORY METHODS OF NUCLEAR MEDICINE. Contributions to the Congress of International Association of Medical Laboratory Technologists, Berlin, August 28–September 1, 1966. Oeff, Karl (ed.) (Freie Universitaet, Berlin (West Germany). Nuklearmedizinische Abt.). Aug. 1966. 95p. (In German).

Among the laboratory methods involved in the operation of a nuclear medicine clinical laboratory are: applications of basic radiation physics and measurement techniques; radiation protection practices; biochemical concepts involved in tracer techniques; radioisotope dilution techniques in clinical diagnostics; methods for measuring resorption and precipitation rates in clinical work; radioimmunological determination of proteohormones; methods of radiochromatography and radioelectrophoresis; applications of histoautoradiography and whole-body autoradiography; and use of neutron activation analysis in biology and medicine. (E.R.B.)

49378 (CONF-680410–, pp 17.1-25) CLINICAL EVIDENCE OF DOSE-RATE EFFECTS IN TOTAL-BODY IRRADIATION IN MAN. Lushbaugh, C. C.; Comas, F.; Edwards, C. Lowell; Andrews, G. A. (Oak Ridge Associated Universities, Tenn.).

Clinical studies of man's reaction to radiation exposure show that his responses differ from those of animals chiefly in quantitative aspects. Much of the problem, however, in establishing precise human dose-response relations stems from uncertainties in depth-dose distribution to such widely dispersed organs as the bone marrow, lymph nodes, and intestines. This is a problem common to all large animals. Large doses of highly penetrating radiation that significantly expose all loci of hematopoietic tissue show that, even then, the temporal development of human lethal syndromes is slower than in animals of similar size. These differences appear to be due to quantitative differences in cellular kinetics and repair mechanisms. Study of the effects in patients undergoing therapy with dose fractionation and protraction greater than one day but less than eight days demonstrates that the effective dose (ED_{50}) for the prodromal symptom complex of patients is increased by about twofold. This decrease in the incidence of symptoms of radiation sickness does not appear to be paralleled to the same degree in pathologic hematopoietic cellular systems as measured by changes in peripheral blood. (auth)

49379 (CONF-680410–, pp 19.1-40) TIME DOSE STUDIES ON HUMAN EPITHELIUM AND TUMORS: SKIN, SQUAMOUS CELL CANCER, RECURRENT BREAST CANCER, MYCOSIS FUNGOIDES, GIANT CELL TUMOR OF BONE AND HODGKIN'S DISEASE. Friedman, Milton; Pearlman, Alexander W. (New York Univ. Medical Center, New York. Hospital for Joint Diseases, New York).

That segment of irradiation dose-time problem, encountered in the treatment of human cancer, encompasses doses ranging approximately from 1000 to 10,000 rads delivered over a period of 1 to 60 days. Studies based on tissues and tumors of capricious human beings are difficult to execute, and are marred by numerous known and unknown variables. Our early studies of reaction to irradiation of human skin and mucous membrane of the head and neck yielded certain qualitative impressions. The effect of a specific dose in time was the product of integrated destruction and recovery. Large doses produce severe destructive effects which tend to be constant in amount because the destructive effect is influenced only by two variables, dose and time. Small doses produce slight destruction and allow greater recovery. Since the recovery phenomena are numerous, and differ in nature from one another, the recovery effects tend to be non-constant in rate and degree. In order to reduce the variables, time-dose studies on 29 patients with multiple nodular chest wall recurrences of carcinoma of the breast were conducted. There were from 4 to 27 lesions in an individual patient, the average being 13. Thus the test objects were histologically, physically, and biologically the same, and the host factors were the same for each group of lesions. Variables were further reduced by means of the minimal corroborated tumor lethal dose tactic. The individual iso-effect curve derived from multiple lesions in a single patient was useful for that patient. When different patients were compared, there was considerable variation in tumor lethal dose and in the slopes of the iso-effect curves (recovery factor). It was not possible to designate a meaningful average iso-effect curve that would be applicable to all cases of carcinoma of the breast. However, the slope of the average iso-effect recovery curve was 0.25. The experiment was repeated for mycosis fungoides; the results were more valid because two patients had 27 and 35 lesions each, which permitted a larger number of interior controls. Additional data was obtained for Hodgkin's disease (484 dose-time points), and multiple benign giant cell tumors on Paget's disease (16 lesions in one patient). The significance of these curves is discussed. Finally, a clinically useful analysis of the data for some lesions consisted of the construction of a scatter diagram containing all the dose points, both successes and failures. The scatter diagram was divided into dose zones with limiting parameters paralleling the slope of the iso-effect curve. The probability of treatment success or failure was calculated for each dose range. (auth)

49380 (COO–1422-22) MEASUREMENT OF BONE MINERAL BY THE DIRECT PHOTON ABSORPTION METHOD: EXPERIMENTAL RESULTS. Sorenson, James A.; Cameron, John R. (Wisconsin Univ., Madison. Dept. of Radiology). Feb. 15, 1968. Contract AT(11-1)-1422. 16p. (CONF-680211–3). Dep. CFSTI.

From Conference on Progress in Methods of Bone Mineral Measurement, Bethesda, Md.

The experimental evaluation of the direct photon absorption method by measuring bone mineral content of humans is discussed. The three aspects of the measurement studied are: (1) accuracy of the method, (2) reproducibility of the method, and (3) clinical applicability of the method, as a means of measuring small changes in bone mineral content taking place over long time periods, and as a method for determining normal and abnormal values for bone mineral content at selected anatomical sites. (auth)

49381 RADIATION PROTECTION ACTION OF ADENOSINE-TRIPHOSPHORIC ACID SODIUM SALT IN EXPERIMENTS ON MICE. Rogozkin, V. D.; Marinenko, E. I. (Inst. of Biophysics, Moscow). Byull. Eksp. Biol. Med., 66: 64-7(July 1968). (In Russian).

Sodium salt of adenosinetriphosphoric acid was administered intraperitoneally in a dose of 350 mg/kg to 180 white mongrel male mice 15 to 20 minutes prior to x irradiation with 650 R (LD 80 to 85/30) and 236 mice intramuscularly in doses of 500, 350, and 200 mg/kg. Survival of protected mice after intraperitoneal administration rose by 41%, after intramuscular administration by 57, 28, 6.2% as compared to the control group. Peripheral blood was tested on the 1, 3, 7, 10, 15, 20, 25 and 30th day after irradiation of 40 mice with prophylactic administration of ATP in a dose of 350 g/kg intraperitoneally; 40 irradiated mice served as control. Results show that after ATP there was less depression of hemopoiesis and it reverted to normal earlier. (auth)

49382 DRUG STIMULATION FOLLOWING REPEATED IMMUNIZATION IN RADIATION INJURY. Evtushenko, A. D. (Chelyabinsk Medical Inst., USSR). Med. Radiol., No. 12, 62-3 (Dec. 1966). (In Russian).

Rabbits were irradiated with 300 R. One group was then inoculated subcutaneously with standard typhoid vaccine (0.5 ml) every other day for 13 days. A day after irradiation they were given the following: vitamin B_{12} (10 mg/kg daily), potassium iodide (10 mg/kg every other day for 3 weeks), and pentoxyl [5-hydroxymethyl-40-methylthiouracil] (40 mg/kg over a period of five weeks). Another group of animals was inoculated after irradiation, but did not receive the drugs. A third group, the control, was neither immunized nor treated with the drugs. The first two groups (irradiated and immunized) had much milder radiation sickness than did the control. They began to move about and eat three days sooner and by the end of the third week after exposure they had regained their original weight, whereas the control did not do so for more than five weeks. The indices of antibody formation, lysozyme titer, and bactericidal properties of the skin were much higher in the first group of rabbits, suggesting that vaccination plus drug therapy stimulated the defensive forces of the body more than did vaccination alone. (JPRS)

49383 ON THE INCREASED EXCRETION OF TAURINE AND BETA-AMINOISOBUTYRIC ACID IN URINE FOLLOWING IRRADIATION AND THE SENSITIVITY OF THESE BIOCHEMICAL REACTIONS; ON THE ORIGIN OF THE INCREASED TAURINE EXCRETION IN IRRADIATED RATS. III. DISCUSSION CONTRIBUTION. Veninga, Tjeerd. Strahlenschutz Forsch. Prax., 4: 236-8(1964). (In German).

Results are reported of studies of the radiation protection effects of biogenic amines in mice. When a mixture of 0.75 mg of serotonin, 7.5 mg of histamine, 0.0075 mg of adrenaline, and

0.25 mg of acetylcholine was administered, 60% survived a single whole-body irradiation with 1250 R. Control animals survived this dose for only four to six days. The mixture of amines was somewhat toxic and increased the mortality from the irradiation treatment. The most toxic mixture consisted of serotonin, histamine, and adrenaline. The presence of acetycholine appeared to reduce the toxic effect. It was suggested that taurine may also be involved in the effects observed, since it is known to be released following irradiation, and even in μg quantities increases the radiosensitivity of red blood cells. Other studies suggested that treatment with 20 to 50 mg/animal of taurine may protect against whole-body irradiation. (BBB)

49384 THE EFFECT OF CHEMICAL PROTECTION AGENTS IN CONDITIONS OF FRACTIONAL IRRADIATION. IV. THE ANTIRADIATION EFFECT WITH THE INTRODUCTION OF PROTECTORS DURING IRRADIATION. Yarmonenko, S. P. Radiobiologiya, 7: 100-4(1967). (In Russian).

Experiments with 650 (20 to 22 g) male white mice using monosodium (β-aminoethyl)phosphorothioate (tsistafos) and 5-(methoxy) tryptamine hydrochloride (mexsamine) as protectors produced new data demonstrating that the protective effect is relatively independent of irradiation dose and to a certain degree, is also independent of the preceding ratiation effect. The following conclusions were reached: use of tsistafos or a combination of tsistafos and mexsamine during irradiation of animals showed a protective effect on the attenuation of the effect of the part of the dose given after injection of protectors; the size of the remaining effective dose, predicted from the size of the dose reduction factor of tsistafos or of the complex, was confirmed in an experiment using a wide range of sublethal and lethal doses (225 to 850 R) with a probability of $P < 0.05$; when the number of megakaryocytes in the femoral bone marrow of mice on the third day after irradiation was used as a criterion, the dose reduction factors of tsistafos, mexsamine, and the complex were, respectively, 1.5, 2, and 3, independent of dosage (300, 450, and 600 R); and reduction of aplasia of the bone marrow, shown in the preservation of part of the cellular population and resulting from administration of these radioprotectors, is considered the basis for subsequent autotransplantation of bone marrow. (ATD)

49385 BLADDER COMPLICATIONS FOLLOWING IRRADIATION IN THE REGION OF SMALL PELVIS. Pupato, F. (Kantonspital, St. Gallen, Switzerland). Urol. Int., 21: 393-436(1966). (In German).

Vesical complications following x-ray therapy in and about the minor pelvis are practically important and therapeutically are often difficult. Based on a review of the literature of the past ten years, frequency, symptoms and signs, direct and indirect etiology, and pathologic anatomy, both gross and microscopic, are considered, with emphasis on the necessity of evaluating urologic status before initiating any treatment in the area of the minor pelvis. The clinical picture and therapy are discussed. Apart from early sequelae, the following delayed reactions may occur: chronic radiation cystitis, contracted bladder, disturbance of vesical emptying, pseudotumor, incrustating cystitis, radiation ulcer, radiation fistula, postirradiation incontinence, and severe vesical bleeding. Several proposals are made for surgery in the irradiated area, especially with reference to the opportune time for surgical intervention. The often severe therapeutic difficulties and the painful symptomatology of irradiation complications involving the bladder demand heightened caution and consideration of prophylactic measures, particularly those concerned with combatting stasis and infection before starting irradiation treatment. (BBB)

49386 PROTON RADIATION FOR ACROMEGALY. New Engl. J. Med., 278: 732(Mar. 28, 1968).

Use of a proton beam to irradiate the pituitary in acromegaly is briefly reviewed. The technique takes advantage of the specially valuable feature of the heavy particles, namely, that those of a given energy all stop at about the same point in tissue, giving up a markedly greater amount of destructive energy in the last centimeter or so before they reach their stopping point, the so-called Bragg peak of linear energy transfer. Even if only one portal is used, the Bragg peak permits the concentration of a dose in the deep target, with no irradiation beyond it. Combining many bilateral portals with this peak centered in the tumor, it is possible to give hypophyseal doses of 10,000 to 12,000 RAD with a high degree of safety. Experience of pituitary irradiations with protons at the Bragg peak now comprises hundreds of patients. The principal disadvantage of radiation destruction of the pituitary gland is the many months required for the full extent of injury to materialize. (BBB)

49387 HEMOTHERAPY OF EXPERIMENTAL ACUTE RADIATION SICKNESS. Babuk, V. V.; Chevlytko (Minsk State Medical Inst.). Med. Radiol. No. 12, 57-8(Dec. 1966). (In Russian).

Dogs irradiated with 600 R were administered a hypertonic solution of calcium chloride, 5% glucose, freshly citrated blood, antibiotics, and vitamins. At the height of the radiation sickness (11 to 16 days after exposure) the treatment prolonged the lives of the animals 10 days or more, but did not keep them from dying. However, when administered seven days after irradiation, 22 of 28 animals survived. A week after treatment, when most of the control animals had already died or were extremely sick, the experimental dogs were externally indistinguishable from healthy animals, although they had elevated body temperatures, accelerated ESR, low erythrocyte and leukocyte counts, and other blood changes. Most of the hematologic indices returned to the original levels within three months. A year after exposure all the animals were found to be normal in every respect. (JPRS)

49388 CHEMICAL RADIATION PROTECTION AGAINST DAMAGES TO THE CYTOPLASM AND THE NUCLEI IN PLANT CELLS BY α AND γ RADIATION. Biebl, R.; Url, W. (Univ., Vienna). Atompraxis, 14: 302-5(July 1968). (In German).

Ionizing radiation may damage the cell in two ways: directly by hits in molecules essential in the life processes, or indirectly by hits in the aqueous phase of the protoplasm and the formation of radiochemical disintegration products of the water molecules. Cell death within 24 hours is believed to be caused by damages to the cytoplasm itself, the slow death after some days, on the other hand, by injuries of the nuclei which have a gradually increasing effect upon the metabolism of the cell. Pretreatment with radioprotective substances (thiourea, thioacetamide, AET, MAT) results in delaying the cytoplasm death, probably by inactivation of the radiochemical disintegration products of water. If the radiation is sufficiently low the nucleus-death may be delayed or even prevented. (auth)

49389 RADIATION FIELD FOR WORK WITH ^{99}Mo/^{99m}Tc COLUMNS AND WITH ^{99m}Tc. Grebe, S. F.; Roemer, M. Atompraxis, 14: 1p.(July 1968). (In German).

The essential risk in using ^{99}Tc lies in working with the ^{99}Mo-^{99}Tc column, especially if the generator must be removed from its lead packing. The extracted ^{99}Tc can be protected easily, and the fingers are exposed only by the handle of the injection syringe. Figures are presented to show isodose curves of a 50 mCi ^{99}Mo-^{99}Tc generator with different shielding ratios, isodose curves of a 20 ml flask filled with 20 mCi ^{99}Tc in an open lead container of 5 mm wall thickness, isodose curves of a 50 mCi ^{99}Mo-^{99}Tc column behind 5 cm of lead, and isodose curves of a 2 ml plastic syringe filled with 1.5 mCi ^{99}Tc. (H.L.W.)

49390 MODERN FIRST AID AND TREATMENT OF BURNS WITH SPECIAL REFERENCE TO MASS CATASTROPHIES. Santler, R. (Univ., Vienna). Wien. Med. Wochenschr., 116: 869-74(Oct. 15, 1966). (In German).

Extensive burns, such as those caused by a nuclear explosion, produce immediate shock and require treatment of the nervous system with drugs to block vagal activity and stimulate sympathetic activity, administration of analgesics and sedatives, and postural adjustments to improve circulation. Various measures, including removal of wet, dirty clothing fragments, proper covering of burns, rapid removal to treatment area, administration of replacement fluids, maintenance of body warmth, etc., are discussed in detail. Classification of burns, need for tracheotomy, movement of burn patients, evaluation of body functions, etc., are itemized. The need for community organization and participation in treatment of catastrophic burn cases is emphasized. (BBB)

49391 ROLE OF "OXYGEN EFFECT" IN THE RADIOPROTECTIVE ACTION OF PROPYLAMINE AND ITS DERIVATIVES. Konstantinova, M. M.; Sokolova, O. M.; Tarasenko, A. G. (Inst. of Biology of Plants, Moscow). Radiobiologiya, 8: 149-50(1968). (In Russian).

White mice of both sexes weighing 18 to 20 g were irradiated with 900 R of ^{60}Co γ rays at 217 R/min. The following were administered in 0.3 ml of distilled water 15, 30, 60, 90 and 120 min before irradiation or measurement of the oxygen content in the tissues: 6 mg of propylamine (PA), 16.5 mg of β-mercaptopropylamine (MPA), 2.75 mg of dimercaptopropylamine (DMPA), 3.6 g of γ-bromopropylamine (MBPA), and 4.5 mg of dibromopropylamine (DBPA). PA had no protective effect and did not influence the oxygen content in the spleen. MPA gave 60 to 80% survival depending on the time between administration and irradiation; no variation of oxygen tension appeared during the period of maximum radioprotective effect (15-60 min). DMPA greatly increased the radioresistance of mice irradiated 30 min after its administration; a decrease of oxygen tension in the spleen was observed. With MBPA and DBPA the protective activity increased in proportion to the time between administration and irradiation (a maximum at 90 min). The results confirm the necessity of a sulfhydryl group in the molecule of the protector. (JPRS)

49392 AN ATTEMPT AT REDUCTION OF A NEGATIVE EFFECT OF PLAGUE IMMUNIZATION ON MORTALITY OF IRRADIATED MICE. Smirnova, O. V. Zh. Mikrobiol., Epidemiol. Immunobiol., No. 10, 109-13(Oct. 1967). (In Russian).

Live plague EB vaccine, treated with specific immune serum (sensitized vaccine), was used to eliminate the negative effect of irradiation. In testing the immunogenicity of the sensitized vaccine the latter gave results almost the same as with the usual EB vaccine protection of albino mice from postcortisone EB-septicemia in experiments performed earlier. Toxicity was tested by titration of the mean toxic dose. The 5010 toxic dose of the sensitized EB vaccine always exceeded the corresponding dose of the usual EB vaccine both for intact and for irradiated mice. A special experiment carried out on 240 albino mice demonstrated a fall of the negative effect of live sensitized EB vaccine on radioresistance of albino mice, irradiated in a dose of 400 R three days after administration of the vaccine. Preliminary administration of the usual EB vaccine conditioned the death of 55.3% of the animals; when the same dose of sensitized vaccine was administered in the same conditions the percentage of animal death fell to 7.5. (auth)

49393 PHARMACOLOGICAL PROTECTION AGAINST LIGHT. Wiskemann, Arthur (Univ., Hamburg). Strahlentherapie, 133: 500-3(Apr. 1968). (In German).

Radioprotective substances, aromatic amino-acids, and antiphlogistics are compared in relation to their ability to inhibit uv-induced inflammatory reactions. The latent period between the time of injection of Evans' blue and the appearance of the color on the shaved and irradiated mouse skin was significantly prolonged by previous administration of cysteamine, histamine, serotonin, pyridoxal-5-phosphate, tryptophan, histidine, rutine, and esculine. Only the administration of serotonin, pyridoxal-5-phosphate, and rutin immediately after irradiation was effective. The threshold of erythema in man was only significantly influenced by phenylbutazone and esculine, but not by oxyphenylbutazone, indomethazine, prednisone, triamcinolone and chloroquine administered one hour before irradiation. Pyridoxal-5-phosphate inhibited erythema in guinea pigs but not in man with a 100-fold lower dose. (auth)

49394 CLINICAL EVALUATION AND RADIOTHERAPEUTIC MANAGEMENT OF HODGKIN'S DISEASE AND THE MALIGNANT LYMPHOMAS. Kaplan, Henry S. (Stanford Univ., Palo Alto, Calif.). New Engl. J. Med., 278: 892-8(Apr. 18, 1968).

The radiation dose-response curve for the eradication of Hodgkin's disease in individual lymph-node chains indicated that a median dose of 500 R results in a 78% true recurrence rate. When the median dose was 1000 R, the rate fell to 60%. On the other hand, with doses of 4000 R, there were only 4% recurrences. Thus, the recurrence rate approached zero at a dose of 4000 R given at the rate of about 1000 R/week. This provides an estimate of the tumoricidal dose for Hodgkin's disease. The dose for reticulum-cell sarcoma, is higher (between 4500 and 5000 R) for an equal degree of probability of tumor control. Also considered is the radiation energy. It is impossible to deliver doses of 4000 R to the lymph nodes in many different areas with 250-kV conventional x rays. This requires megavoltage energy beams. The mantle-field technic is described which employs parallel opposed anterior and posterior fields shaped to encompass all the nodes on both sides of the neck, the infraclavicular regions, both axillary regions, and the hilar and mediastinal nodes down to the diaphragm. During therapy, care is taken to protect the lungs and other vital tissues by a thick lead ingot cut to the size and shape for each patient on the basis of chest roentgenograms. With such meticulous technic, radical treatment can be accomplished safely. Complications of this technique are listed. The skin tolerates megavoltage irradiation to the dose level used (4000 R) with few or no sequelae. The rate of significant limitation of pulmonary function after such radiotherapy is about 3 to 5%. By the use of the interruption technic the frequency of severe complications in the lung can be minimized. The hematopoietic system is not seriously affected and severe leukopenia or thrombocytopenia is seldom a problem. (BBB)

49395 INTRA-ARTERIAL 5-BROMODEOXYURIDINE AND X-RAY THERAPY. Bagshaw, Malcolm A.; Doggett, R. L. Scotte; Smith, Kendric C.; Kaplan, Henry S.; Nelson, Thomas S. (Stanford Univ., Palo Alto, Calif.). pp 43-55 of Progress in Biomedical Engineering. Fogel, Lawrence J.; George, Frederick W. (eds.). New York, Spartan Books, 1967.

From Symposium on Biomedical Engineering, San Diego, Calif., June 20–22, 1966. See CONF-660660.

Patients with advanced untreated epidermoid carcinoma of the head and neck were treated by x radiotherapy alone (6000 rads in six weeks, at 200 rads daily, to the primary and all positive lymph node regions); arterial infusion of methotrexate and citrovorum factor for two weeks, followed by radiotherapy; or preirradiation arterial infusion with methotrexate followed by preirradiation arterial infusion of 5-bromodeoxyuridine (BUdR) administered for four days before radiotherapy. In this group of patients there was strong clinical evidence for the radiation hypersensitivity of tissues included in the BUdR infused arterial bed. However, no greater change in the course of the disease was observed than that in patients treated by radiotherapy alone. (C.H.)

49396 COMPARATIVE STUDY OF THE HISTOPATHOLOGY AND OF THE INCORPORATION OF ^{14}C-VITAMIN K_3 WITH RADIOSENSITIVITIES OF RATS. Grigoresco, St.; Nedelco, C.; Nastase, M.; Apostolesco, R. (Centre de Radiobiologie et de Biologie Moleculaire, Bucharest). Int. J. Radiat. Biol., 13: 505-10(1968). (In French).

A comparative study of the histopathology of internal organs of x-irradiated rats treated with ^{14}C-vitamin K_3 was made. Control rats did not receive vitamin K_3. The largest quantities of ^{14}C-vitamin K_3 were absorbed by the adrenal glands and intestine and it was concluded that these organs play a significant role in radiosensitization. (H.L.W.)

49397 SKIN REACTIONS IN COMPLEX EMPLOYMENT OF RADIATION AND CHRYSOMALLINE. Astrakhan, V. I.; Nivinskaya, M. M.; Starichkov, M. S. (Inst. of Experimental and Clinical Oncology, Moscow). Med. Radiol., 13: No. 8, 16-19(Aug. 1968). (In Russian).

Local and general reactions in 68 patients were different neoplastic processes who were subjected to radium therapy and intravenous administration of the antiblastic antibiotic chrysomalline were analyzed. An intensification of reactions of the skin and mucous membrane was noted in 41 (60.3%) patients, phenomena of general intoxication in 44 (68%), an inhibition of the hematopoietic system in 36 (53%) cases. The changes directly depended on the dose and the individual sensitivity of each patient. Among 22 patients receiving short-focus x irradiation an intensification of the skin reaction was observed in 19 (90%), out of 22 subjected to classical roentgen therapy, and in 12 (50%), out of 30 subjected to telegamma-irradiation, in 10 (33%). All the reactions were reversible. It was concluded that chrysomalline, like actinomycin-D, causes a potentiation of the radiation effect. This fact should be taken into consideration during the institution of complex therapy. (auth)

49398 STATUS OF PLACENTAL SCANNING WITH TECHNETIUM BOUND TO SERUM ALBUMIN. Johnson, Philip M.; Sciarra, John J. (Columbia Univ., New York). Lahey Clin. Found. Bull., 17: 35-42(Jan.-Mar. 1968).

The characteristics, distribution, and use of serum albumin labeled with ^{99m}Tc for placental scanning are discussed. Either NaI solution, 50 mg administered intravenously; Lugol's solution, 10 drops administered orally 3 times daily; or KCl, 200 mg administered orally, will effectively block thyroidal and gastric concentration of ^{99m}Tc in mother and fetus. Intravenous administration of NaI is useful when there is insufficient time for oral preparation. This must be followed by Lugol's solution for 24 hr. A dose of 750 to 1000 μCi is adequate. The placental crossover of ^{99m}Tc tracer and fetal radiation dose are discussed. The data obtained from 10 patients indicate that the ratio of the radioactivity in maternal blood to that in the blood of the fetal cord is not significantly greater than that found after administration of albumin labeled with ^{131}I or ^{51}Cr. Radioactivity in fetal plasma ranged from 1.4 to 3.3% of the maternal plasma concentration in 4 patients who received ^{99m}Tc-labeled albumin ½ to 28 hr earlier. The maternal radiation dose from 1 mCi is 0.05 rad to the blood; the total fetal blood dose is about 0.014 rad. These values are far below those resulting from radiographic techniques. The kidney forms an excretory pathway for unbound ^{99m}Tc. (BBB)

49399 SECTION SCANNING WITH A LARGE SOLID-ANGLE COLLIMATED DETECTOR OR SYSTEMS OF DETECTORS. Cassen, B.; Crandall, P. (Univ. of California, Los Angeles). pp 109-14 of Progress in Biomedical Engineering. Fogel, Lawrence J.; George, Frederick W. (eds.). New York, Spartan Books, 1967.

From Symposium on Biomedical Engineering, San Diego, Calif., June 20–22, 1966. See CONF-660660.

A radioisotope scanning system is described that provides quantitative information on the distribution of ^{99}Tc during section scanning of the brain for localization of tumors. The system uses a large, spherical-cap-shaped detector made with irregular broken crystals of sodium iodide immersed in a liquid, a collimator, and an array of seven photomultiplier tubes. A hydraulic scanning drive allows scanning a brain section in four minutes or less. To avoid the hazards of moving large masses over the patient, the

collimator is scanned under the patient. Vertical adjustments enable horizontal scanning through a series of planes and the focal point can be adjusted from the patient table top to four inches above it by raising or lowering the whole collimator and crystal assembly hydraulically. This four-inch range of vertical adjustment was found to be adequate for both lateral and anterior-posterior brain section scanning. (C.H.)

49400 APPLICATION OF THE IMPEDANCE PNEUMOGRAPH TO CHEST RADIOGRAPHY. Sargent, E. Nicholas (Orange County General Hospital, Orange, Calif.); Robertson, Thomas L. pp 97-103 of Progress in Biomedical Engineering. Fogel, Lawrence J.; George, Frederick W. (eds.). New York, Spartan Books, 1967.

From Symposium on Biomedical Engineering, San Diego, Calif., June 20–22, 1966. See CONF-660660.

The impedance pneumograph x ray actuator is accurate, making the x ray exposure at any desired phase of respiration. The device is especially useful in obtaining films with maximum inspiration or maximum expiration in uncooperative children and adults. It is relatively inexpensive, lightweight, portable, easily applied to the patient, and the electrodes are noncontaminating. Fewer "retake" examinations are necessary, thus decreasing unnecessary radiation exposure to the patient and the surrounding personnel. When used in association with an automatic cassette changer, two films can automatically be obtained in inspiration and expiration, if the automatic reset mode is selected. It has many possibilities for future applications. The ECG reading is possible from the same set of electrodes, so that correlation of the respiratory and cardiac phase with x ray exposure is possible. Future studies could include correlation of radiographic findings with impedance spirometry measurements, both in health and disease. Further investigation of the correlation between impedance changes, radiographic chest findings and therapeutic response during treatment of chest diseases could also be conducted. Although the present instrument does not directly measure impedance in actual units, future instruments can be calibrated to correlate actual impedance with chest diseases, industrial air pollution, and smoking. Correlation of impedance changes with actual diaphragmatic movements and cinefluorography is also possible. Transthoracic impedance changes associated with lung neoplasms and possible relationship to hypertrophic pulmonary osteoarthropathy are other subjects for investigation. (auth)

49401 QUASI-GAUSSIAN DEFOCUSING OF THE RADIOISOTOPE SCAN. Oldendorf, William H. (Wadsworth General Hospital, Los Angeles. Veterans Administration Center, Los Angeles. UCLA Center for the Health Sciences, Los Angeles); Palmer, John; Patton, Dennis D. pp 83-95 of Progress in Biomedical Engineering. Fogel, Lawrence J.; George, Frederick W. (eds.). New York, Spartan Books, 1967.

From Symposium on Biomedical Engineering, San Diego, Calif., June 20–22, 1966. See CONF-660660.

It has been shown that the high-frequency artifacts introduced by the radioisotope scanning system (image elements with sharp edges, and scan lines), when viewed at the standard distance of 1 m, produce images on the retina that are close to the optimal spatial frequency for physiological optical response. These artifacts are seen with greater efficiency by the viewer than the desired clinical information in the scan itself, which, being of lower characteristic frequency, produces a lesser response. For these reasons it is of value to suppress the high-frequency artifacts produced by the scanning system itself. Since the sensitivity distribution of the collimator is quasi-Gaussian, the best fit of defocusing of the final aperture is also quasi-Gaussian. This can be accomplished either by a diffuser located between the light source and the film, or, more flexibly, by the darkroom processing technique reproducing the finished conventional scan image described here. Producing an artificially sharp scan retains all of the original scan information about isotope distribution but superimposes a great deal of high-frequency noise. Subsequent low-pass filtering through manipulation during photographic reproduction offers a great deal of flexibility and simplifies the original scan procedure. (auth)

49402 DUAL-CHANNEL TECHNIQUE FOR ELIMINATION OF THE LIVER IMAGE FROM SELENOMETHIONINE PANCREAS ORGAN SCANS. Kaplan, E.; Ben-Porath, M.; Fink, S.; Clayton, G.; Jacobson, B. (Veterans Administration Hospital, Hines, Ill.). pp 115-23 of Progress in Biomedical Engineering. Fogel, Lawrence J.; George, Frederick W. (eds.). New York, Spartan Books, 1967.

From Symposium on Biomedical Engineering, San Diego, Calif., June 20–22, 1966. See CONF-660660.

A method of scintiscanning the pancreas is described in which the patient is injected intravenously with both ^{75}Se-selenomethionine and colloidal ^{198}Au. The selenomethionine is concentrated in both the liver and pancreas and the gold in only the liver. The liver image is eliminated by subtracting the gold isotope photopeak from that of ^{75}Se. The electronic system is shown in a block diagram and a detailed circuit diagram is included. (C.H.)

49403 PANCREATIC SCANNING. Bouchier, Ian A. D. Gut, 8: 421-2(Oct. 1967).

Visualization of the pancreas by radioisotope scanning is briefly reviewed, with a discussion of choice of the isotope, instrumentation, and interpretation of the scans. The pancreas has a marked affinity for ^{35}S-methionine; but ^{35}S emits β rays only and penetration of β rays in tissues is not sufficient to permit external scanning. However, because of the chemical similarity between S and Se, ^{75}Se selenomethionine (synthesized by yeast) can be used. Selenomethionine has the same properties as methionine and is incorporated intact into pancreatic proteins without prior metabolic change. Techniques for performing pancreatic scans vary, but generally 3 μCi/Kg body weight of the isotope is administered intravenously and surface scanning is commenced between one-half to one hr later. The isotope is concentrated by both the pancreas and the liver, hence it is essential to follow the selenomethionine scan with a colloidal ^{198}Au scan (which outlines the liver but not the pancreas). The pre-scan preparation of the subject is discussed. Of the scanning machines available, best results are obtained with a large (5-in.) crystal and a broad-focus collimator. It is an advantage to record the scintillations both in black and white on photosensitive paper (the photoscan) and as a colored outline (the scintiscan). Selenium-75 has a 120-day physical half life in man of 56 days. The whole-body radiation dose is 1.3 R, within the acceptable range for diagnostic procedures. (BBB)

49404 RECORDING DEVICE FOR A SCINTILLATION SCANNER. Kodama, Mashio (to Hitachi Ltd.). Japanese Patent 1968-6505. Mar. 11, 1968. Filed Mar. 5, 1963.

In scintillation scanning for a cerebral tumor in the head, two scintillation detectors are placed on each side of the skull and the lesion is observed by means of the difference in the detected counts; the image is shown by the dots on the recording paper. The anatomical location of the lesion cannot usually be shown. A method is described for localization of the neoplasm. In putting the line dots on the recording paper, an inclination is given to the dot line, corresponding to the positive or negative value of the difference in the two detected counts; the inclination is produced by the recording rod, operated by the sign of the difference. (NSA of Japan).

49405 CORE STORAGE SCINTIGRAPHY, A NEW SCINTIGRAPHIC INTERPRETATION PROCEDURE. Boerner, W.; Moll, E. (Univ., Wuerzburg, Ger.). Klin. Wochensch., 44: 410-11 (Apr. 1, 1966). (In German).

The use of a 4096 channel storage memory and display unit for use in scanning with ^{99m}Tc and other radioisotopes is discussed. The equipment combination permits continuous subtraction of background and areas of decreased intensity, selective removal of areas of greatest intensity, visualization of zones of uniform count density, brightness modulation as a function of count storage intensity, and imposition of coordinates in the x and y areas, with visualization of activity profiles along the selectable areas. The equipment and methods used permit recognition of smaller count intensity differences than do color or photoscintigraphy. However, evaluation of the scans requires more time and the equipment required is more expensive. (BBB)

49406 PRODUCTION OF ^{11}C LABELED COMPOUNDS FOR NUCLEAR MEDICAL APPLICATION USING AN ELECTRON LINEAR ACCELERATOR. Theard, L. M.; Grece, D. E. (General Atomic Div., General Dynamics Corp., San Diego, Calif.). pp 29-41 of Progress in Biomedical Engineering. Fogel, Lawrence J.; George, Frederick W. (eds.). New York, Spartan Books, 1967.

From Symposium on Biomedical Engineering, San Diego, Calif., June 20–22, 1966. See CONF-660660.

The importance of ^{11}C-labeled compounds in nuclear medicine, the use of an electron linear accelerator to produce ^{11}C by the ^{12}C(γ,n)^{11}C reaction, and some chemical reactions that may influence the identity, total activity, and specific activity of the ^{11}C-labeled compounds produced are discussed. It is pointed out that compounds labeled with ^{11}C would be useful in nuclear medicine because of several characteristics. First, ^{11}C decays solely by the emission of a positron. Because of subsequent positron-electron annihilation, two γ photons of 0.51 MeV energy are emitted at nearly 180° with respect to each other. The penetrating character of the γ radiation allows the detection of ^{11}C by scanning devices located outside the human body. Another advantage of ^{11}C is that the simultaneity of the two γ photons produced by positron-electron

annihilation permits the use of coincidence counting techniques in scanning. These techniques improve detection sensitivity and facilitate the determination of the spatial origin of the radiation. A further advantage of ^{11}C is that its half-life is 20.4 min, thus, with ^{11}C-labeled compounds, higher initial activities may be utilized for faster scanning, while at the same time the total radiation dosage delivered to a patient tends to be lower. In addition, the nuclear medical diagnostics can be repeated within a short time. Currently, there is considerable interest in utilizing ^{11}C-labeled thymidine to detect cancerous tissue. It is reasoned that the advantageous properties of ^{11}C would allow detection of greater uptake by normal tissue. It is likely that the demonstration of ^{11}C labeling of various other biologically important compounds will induce investigation of new nuclear medical applications to take advantage of the varied specific functions performed by body chemicals containing carbon. (C.H.)

49407 SYNOVIORTHESIS WITH RADIOISOTOPES. Delbarre, F.; Cayla, J.; Menkes, C.; Aignan, M.; Roucayrol, J.-C.; Ingrand, J. (Hopital Cochin, Paris). Presse Med., 76: 1045-50(May 4, 1968). (In French).

A new, radioisotope method was developed to treat arthritic inflammation of the joints. Dosimetric studies of gonadal exposures with this technique were reported. A total of 194 injections of radioactive substances were made to counteract synovial proliferation in 11 patients with arthritis over a two-yr period. Isotopes emitting β rays were used including ^{198}Au (84 times) and ^{90}Y (110 injections). They were injected in the form of colloidal particles with an average diameter of 300 Å. During the intra-articular injections, precautions were taken to prevent contaminating the surroundings or the technician. Following the radioisotope, corticoids were injected through the same needle. Doses used were 6 mCi for the knee joint, 1 mCi for wrists and elbows, 2 mCi for shoulders, 3 mCi for the hip joint, and doses smaller than 1 mCi for finger joints. When several injections in one day were given, the dose did not exceed 7 mCi. Treatments were repeated when necessary at intervals varying from 15 days to 11 months. Tolerance of treatment was good; secondary reactions occurred in 39 out of 83 cases (47%) but were benign. An analysis of the results several months later provided a guide of indications and contraindications for this method. A table was given of physical and biologic characteristics of the principal radioisotopes used for synoviorthesis. With ^{198}Au, which has a half-life of 2.69 days and maximum energy of β radiation of 0.9 MeV, the tissue penetration was from 1 to 3.6 mm. For ^{90}Y the corresponding figures are 61 hr, 11 MeV, and 3.5 and 11 mm, and for ^{32}P 14.3 days, 1.7 MeV, and 2 to 7 mm. Dosimetric results were also presented, showing that with the use of 3 mCi of ^{198}Au in the hip joint the exposure of the ovaries was 30 R and the testes 9 R. Use of 6 mCi of ^{198}Au in the knee joint resulted in an ovarian dose of 0.15 R and a testicular dose of 0.3 R. It was concluded that this method was preferable to surgery for treatment of arthritic inflammation of the synovium. (BBB)

49408 A NEW METHOD OF BEAM DIRECTION, WITH PARTICULAR APPLICATION IN HYPERBARIC OXYGEN THERAPY. Sutherland, W. H. (Velindre Hospital, Cardiff, Wales). Brit. J. Radiol., 41: 633-6(Aug. 1968).

A method is described for the direction of a beam of supervoltage x rays as it travels from the entrance point through the patient during radiotherapy. In the method described, a portion of the field defining light beam is intercepted by a lens attached to the nosepiece of the accelerator and is made to converge towards the patient. The wax block on the plastic beam-direction shell is surfaced with a thin sheet of Perspex that reflects sufficient amounts of the converging light beam to give an image of the filament of the projector lamp on an opaque disk glued to the center of the lens. Applications for hyperbaric oxygen therapy are discussed. (C.H.)

49409 THE PROPOSED LOS ALAMOS MESON PHYSICS FACILITY AND SOME POSSIBLE APPLICATIONS TO BIOMEDICINE. Rosen, L. (Los Alamos Scientific Lab., N. Mex.). pp 225-33 of Progress in Biomedical Engineering. Fogel, Lawrence J.; George, Frederick W. (eds.). New York, Spartan Books, 1967.

From Symposium on Biomedical Engineering, San Diego, Calif., June 20-22, 1966. See CONF-660660.

Pion beams, by use of appropriate absorbers and electromagnetic steering, may be produced in a wide variety of configurations. They may be made to penetrate either wide or narrow regions. With the beams produced at the Los Alamos Linear Accelerator, every portion of an animal or human organism would be accessible to irradiation by monoenergetic beams of pi-minus mesons. Such radiations can be used to produce localized lesions for studies in medicine and biology and for the treatment of disease. The Los Alamos Meson Physics Facility will be a national facility, open to the nation's community of scholars. (auth)

49410 ACTIVATION ANALYSIS. Kramer, Henry H. (Union Carbide Corp., Tuxedo, N. Y.); Wahl, Werner H. pp 811-32 of Principles of Nuclear Medicine. Wagner, Henry N. Jr. (ed.). Philadelphia, W. B. Saunders Co., 1968.

The principles on which neutron activation analysis is based and the applications of the method to biomedical problems are described. The topics discussed include neutron reactions, production of a radionuclide, quantitative elemental analysis, separation of radionuclides, neutron sources, radionuclide detection methods used in activation analysis, major problems in the analysis of trace elements in biological tissues, and biomedical applications. 48 references. (M.M.B.)

49411 PRINCIPLES OF NUCLEAR MEDICINE. Wagner, Henry N. Jr. (ed.). Philadelphia, W. B. Saunders Co., 1968. 912p.

Diagnostic and therapeutic uses of nuclear methods are reviewed. Separate abstracts have been prepared for chapters on activation analysis, dosimetry, radiation injury, and safety. Other chapters in the book cover the diagnostic process, mathematics, basic physics of nuclear medicine, measurement of radioactivity, physical principles of radionuclide scanning, whole-body counting, liquid scintillation counting, the radiopharmaceutical, the thyroid gland, metabolic diseases, the blood, the lung, the circulation, the gastrointestinal tract, liver, and pancreas, the kidney, the nervous system, the skeleton, in vitro tests, and technical details of common procedures. An appendix includes tables on physical constants, conversion factors, organ weights, dose limits, and other data for use in absorbed dose calculations. (M.M.B.)

For abstracts of individual chapters see: 49329, 49330, 49410, and 49535.

49412 PROTECTION AGAINST WHOLE-BODY IRRADIATION BY DIETS OF INERT NONABSORBABLE SUBSTANCES. Friedman, M. H. F.; Tansy, M. F.; Rosenfeld, L. M.; Kramer, S. (Jefferson Medical Coll., Philadelphia). Monogr. Nucl. Med. Biol., No. 1, 421-32(Feb. 1968).

From Gastrointestinal Radiation Injury Symposium, Richland, Wash. See CONF-660917.

A comparative study was made of gastrointestinal (GI) function in irradiated rats maintained on inert dietary supplements and similarly treated rats fed stock rations. Changes in body weight, food consumption, water intake, feces output, and the histological findings are reported. Also presented are experimental studies on spontaneous and induced GI motor activities, gastric evacuation and intestinal transit times, and determinations of GI cholinesterase and serotonin levels. The inert dietary supplements afforded protection against the damaging effects of whole-body γ radiation. Materials found effective were $Mg_3Si_4O_{11} \cdot H_2O$, Al_2SiO_5, and methyl cellulose, but not barium sulfate. Experiments with charcoal were inconclusive. Radiation protection was not evident until 10 or more days after feeding of the inert materials in concentrations of 20 to 30%. In general, the degree of protection increased with length of time the rat was on the diet. (M.M.B.)

49413 UREASE IMMUNITY IN IRRADIATION INJURY WITH CONSIDERATION OF GROWTH AND LIVER INSUFFICIENCY. Visek, W. J.; Dang, H. C. (Cornell Univ., Ithaca, N. Y.). Monogr. Nucl. Med. Biol., No. 1, 292-302(Feb. 1968).

From Gastrointestinal Radiation Injury Symposium, Richland, Wash. See CONF-660917.

Investigations with urease immunity in mice exposed to whole-body irradiation were undertaken after evidence in growing animals and in liver insufficiency indicated that the quantity of ammonia produced by urea hydrolysis was especially significant under stressful conditions. A limited amount of data was obtained that showed increased survival in irradiated mice actively immunized with jackbean urease. Passive transfer of heterologous antisera before irradiation significantly increased survival in mice exposed to lethal dosages of whole-body γ irradiation. Aminoethylisothiuronium (AET) and mercaptoethylamine (MEA) alone and in combination with antiserum enhanced survival of irradiated animals. (M.M.B.)

49414 CYTOLOGIC CHANGES IN THE INTESTINE AFTER RADIATION PROTECTION. Braun, H. (Univ., Freiburg i. B.). Monogr. Nucl. Med. Biol., No. 1, 94-100(Feb. 1968).

From Gastrointestinal Radiation Injury Symposium, Richland, Wash. See CONF-660917.

The radioprotective compounds, cysteine and 5-mercaptopyridoxine, and the non-protective compounds, isocysteine and 4-mercaptopyridoxine were injected into mice. The radioprotective compounds induced a typical swelling of the mitochondria in intestinal crypt cells that did not occur in mice fed the nonprotective compounds. (M.M.B.)

49415 STUDIES ON THE INHOMOGENEITY QUOTIENT OF SIEVE IRRADIATION. INHOMOGENEITY QUOTIENT OF SOME KINDS OF SIEVES AND THEIR BIOLOGICAL EFFECT. Yamada, Chikahisa (Kyoto Prefectural Univ.). Nippon Igaku Hoshasen Gakkai Zasshi, 28: 139-49(May 1968). (In Japanese).

There are two important factors in sieve x radiotherapy. One is the field-size factor, that is, the diameter of the hole and ratio of the open area, the other is the inhomogeneity quotient (IQ) which is the ratio of the maximum dose at the open area to the minimum dose at the covered area. The IQ was calculated on several sieves of aluminum, copper, and lead under 100 and 180 kV x irradiation, and the relationship between the biological sieve effect ratio (BSER) and IQ of three kinds of sieves was studied by evaluating the LD 50/30 after whole-body irradiation of mice. It was demonstrated that the LD 50/30 with the conventional irradiation was 589 R, LD 50/30 of sieve irradiation of IQ 2.0, 2.7, and 3.7 at 1 cm depth (center of mouse) was 619, 694, and 891 R respectively. The biological sieve effect ratios of IQ 2.0, 2.7, and 3.7 were 1.05, 1.18, and 1.51. From these results, it was verified that the sieve irradiation with the IQ more than 2 was effective. (NSA of Japan)

49416 PROGRESS IN BIOMEDICAL ENGINEERING. Fogel, Lawrence J.; George, Frederick W. (eds.). New York, Spartan Books, 1967. 333p. $12.00. (CONF-660660).

Separate abstracts were prepared on eight papers. Twenty-one additional papers discuss new equipment for use in electrocardiography and electroencephalography, computer aids diagnosis, statistical problems in medical diagnosis, and biomedical considerations in outerspace activities. (C.H.)

For abstracts of individual papers see: 49029, 49215, 49399–49402, 49406, and 49409.

49417 EFFECT OF COLLIMATOR RESOLUTION ON THE DETECTION OF LESIONS IN BRAIN SCANNING. Matthews, C. M. E.; Kibby, P. M. (Hammersmith Hospital, London). Brit. J. Radiol. 41: 580-5(Aug. 1968).

Photoscans were made of phantoms representing tumors in brain using a single scintillation detector with a 3 × 1 in. NaI crystal. The phantoms consist of a 5 l tank containing 0.043 μCi/ml of ^{99m}Tc with spherical glass bulbs containing 0.43 μCi/ml of ^{99m}Tc representing the tumors. Bulbs of diameters from 0.9 to 2.7 cm were scanned with two collimators with 50% resolution diameters of about 1.2 and 2.5 cm, both collimators being designed for uniform resolution with depth. It is shown that, in agreement with theoretical predictions, smaller bulbs can be detected with the coarser resolution collimator than with the finer resolution one. The statistical test of significance of increase in count rate used in the theoretical calculation correctly predicts whether a bulb of a given size will be detected; this calculation uses only the physical dimensions of the collimator, the crystal efficiency, the radioactivity in the bulb and tank, the tank thickness and the bulb volume. The scans are much improved if most of the scattered radiation is cut out by setting the bottom of the analyzer window at 90% of the photopeak energy. (auth)

49418 PHYSICAL COMPARISON OF GAMMA CAMERA AND TWO-HEADED SCANNER: FIGURES OF MERIT AND TIMES REQUIRED FOR THRESHOLD DETECTION OF SPHERICAL SOURCES. Westerman, B.; Stead, M.; Fowler, J. F. (Hammersmith Hospital, London). Brit. J. Radiol., 41: 586-96(Aug. 1968).

Physical comparisons are described between a scintillation camera and a two-headed collimated scintillation scanner for their efficiency in detecting radioactive spheres in tanks of water containing radioactivity at different concentrations. For these comparisons, the previously defined figure of merit has to be modified to use counts recorded per integrating time, i.e., time spent over the abnormal region instead of per minute. A new quantity, merit-time-product, is defined and used for this purpose. It is then possible to compare scanners moving at different speeds with each other or with cameras, on the same basis. Results are presented showing the total times required for each device to scan an area, so that a given level of significance is achieved in the threshold detection of active spheres in the presence of background radioactivity. The scintillation camera requires shorter times. The differences are small for ^{131}I, but exceed factors of 20 in overall time for ^{99m}Tc. These factors decrease with depth in the scintillation camera, from 20 to 30 at 7 cm to about 10 at 10 cm depth. Possibly the most striking difference between the camera and the two-head scanner is the high efficiency of the camera for relatively shallow tumors and the rapid decrease of efficiency with depth. (auth)

49419 THE RELATIVE EFFECTS OF FAST NEUTRONS AND X RAYS ON TUMOUR AND NORMAL TISSUE IN THE RAT. PART II. FRACTIONATION: RECOVERY AND REOXYGENATION. Field, S. B.; Jones, T.; Thomlinson, R. H. (Hammersmith Hospital, London). Brit. J. Radiol., 41: 597-607(Aug. 1968).

In rats, an experimental sarcoma known to contain hypoxic cells, and the normal tissue of the foot were irradiated with fractionated doses of x rays and of fast neutrons, each dose separated by 24 hours. For equal damage to normal tissue the therapeutic effect of x rays was improved by fractionation, but in this experimental system neutrons were always still more effective on the tumor. This result is explained by the fact that the population of tumor cells surviving a dose of radiation is largely hypoxic, but that the proportion of hypoxic cells is reduced in time. However, at 24 hours after irradiation this proportion is still greater than in the untreated tumor. Late damage and deformity of the normal tissue, relative to early damage, was the same for single doses, two or five fractions of x rays, or of neutrons. However, for all treatments, once above a certain dose level, a small increase led to a small increase in early reaction, followed by a very large increase in late reaction and deformity. The rate of increase of neutron RBE with increasing numbers of fractions was similar to that found in pig skin and in human skin. By comparison with the single dose, recovery after neutron irradiation was less than after x rays by 0.4 for the early skin reaction and by 0.6 for the late reaction and for deformity. (auth)

49420 WHOLE-BODY RADIATION COUNTERS. Burkinshaw, L.; Spiers, F. W. (General Infirmary, Leeds, Eng.). J. Physiol. (London), 191: 66P-8P(July 1967).

The two counters that are described and illustrated were designed to measure small quantities of γ-emitting radioisotopes in the human body. One of the counters consists of three large plastic scintillation detectors grouped around a chair. The other is made up of four 6-in. dia × 4-in. thick scintillation crystals, Tl-activated NaI, two above and two below a horizontal couch. To shield the counters from γ radiation in their surroundings, otherwise the small activities to be measured would be masked by the background count rate, each instrument is housed in a cubicle with walls of steel, 5 in. thick, lined with 1 in. of lead. The two counters have different properties. The plastic counter has very high sensitivity, because its detectors are large, but it has only moderate energy resolution. The NaI counter has lower sensitivity, but has good energy resolution. Moreover, its four crystals can be placed over different parts of the body to study the distribution of radioactivity. The plastic counter is used mainly for measuring the amount of K in the body, on the basis of the long-lived radioisotope, ^{40}K, which emits 1.46-MeV γ rays. This technique is being used to study changes in body K after ureterocolic anastomosis, during peritoneal dialysis, and in manic depressive psychosis. The NaI counter can also be used to measure either natural or acquired body radioactivity. For instance, it was used to follow the increase in the amounts of K and ^{137}Cs in babies from 10 days to 6 months after birth, and to measure the retention by patients of ^{47}Cs given intravenously. (BBB)

49421 MODIFICATION OF ACUTE RADIATION EFFECT ON CEREBELLAR NEURONS OF MICE BY ACTINOMYCIN D. Zeman, W.; Ordy, J. M.; Samorajaki, T. (Indiana Univ., Indianapolis). Exp. Neurol., 21: 52-7(May 1968).

Adult C57BL/10 male mice were exposed to 4 parallel, longitudinally oriented beams of 20-MeV deuterons, 0.025 mm wide and 9 mm long. The absorbed dose in the proximal third of the beam path delivered in 8 sec was about 66,000 Rad. Some mice received intraperitoneal injections of 0.1 μg/g body weight actinomycin D 1, 6, and 24 hr later. The mice were killed 6 and 24 days after the exposure. Six days after irradiation, practically all granule cells of the cerebellum were destroyed, but 88% of the Purkinje cells survived. Actinomycin D when given 1 hr after irradiation modified this response so that only 22% of the exposed Purkinje cells remained morphologically intact. After 24 days the respective survival rates were 48 and 17%. When actinomycin was given 24 hr after exposure, the rate of surviving Purkinje cells was 73% at 6 days and 49% at 24 days, respectively. Evidently a certain type of acute lethal radiation damage to these neurons is repaired within a few hours following irradiation. (BBB)

49422 CAN N-ETHYLMALEIMIDE PREFERENTIALLY RADIOSENSITIZE HYPOXIC TUMOUR CELLS IN VIVO? Moroson, H.; Furlan, M. (Sloan Kettering Inst., Rye, N. Y.). Int. J. Radiat. Biol., 13: 585-9(1968).

Mice were injected intraperitoneally with P388 tumor cells; they were then given NEM (N-ethylmaleimide) 20 min before whole-body x radiation. Animals were killed at daily intervals following treatment with NEM alone, x ray alone, or NEM plus x ray; the tumor cells were washed from the peritoneal cavity and counted in a Coulter counter. Although NEM is found to be a radiation sensitizer for tumor cells in vivo it does not have a

preferential sensitizing capacity for hypoxic tumor cells. Increasing the dose of either radiation or drug alone can also increase tumor cell killing, but at the expense of host toxicity and earlier host mortality. It appears that the mechanism of enhancement of radiation killing by NEM is not attributable to additive toxicity effects and may involve greater permeability of cancer cells to the drug following radiation. (H.L.W.)

49423 STUDY OF RESULTS OBTAINED BY RADIATION USED ALONE IN A SERIES OF 168 CASES OF CERVICAL CANCER IN ALL STAGES OF DEVELOPMENT. CONSIDERATION OF THE FAILURES AND SEQUELAE OF THE TREATMENT. **Segers, G.; Dancot, H.** Bull. Soc. Roy. Belge. Gynecol. Obstet., 35: 313-28(1965). (In French).

A study was made of the clinical results and side-effects of irradiation treatments, used alone, in 168 cases of cervical cancer at various stages. Radium implantation was followed by conventional x-ray therapy (200 to 230 kV). Two applications of Ra to the vagina and uterus simultaneously for 50 to 70 hr each time were given, with an interval of six to eight days between treatments. The dose administered at 2 cm from the cervix was 7000 R and at 5 cm from the cervix, in the lymph nodes, it was 1500 to 2500 R. Radiography was used to control placement of the Ra. The dose to other lymph nodes higher in the pelvis was not sufficient for eradication of the tumor. Therefore, after 12 to 15 days the external parametria and pelvic lymph nodes were irradiated with x rays at a dose of 2500 to 4000 R, making the total minimum dose in the area 4000 R. The 5-yr recovery rate was 58%. Complications occurred in some cases. One patient had intestinal stenosis that necessitated resection of a 15-cm length of intestine. Several cases of indurated parametria were noted, as well as one case of radioinduced cystitis one yr after treatment that was cured. There were no urethral fistulas or bone injuries. (BBB)

49424 PHOTOSENSITIVITY CAUSED BY NALIDIXIC ACID. **Baes, H.** (Univ. Hospital, Leiden). Dermatologica, 136: 61-4(1968).

Ultraviolet irradiation studies were carried out on a woman, aged 49, who had been suffering for three yr from chronic pyelonephritis, with redness and blistering on the exposed extremities. Four weeks earlier she had developed severe sunburn, with development of bullae. Exposure to the sun had been very intense, previous to and during the skin eruption. Nalidixic acid, 3 g daily, had been taken continuously for 3 months. She had never suffered previously from photodermatosis. Histological examination of the margin of a blister revealed a subepidermal bulla. Several small parivascular round-cell infiltrates were seen in the corium. The roof of the bulla in some parts showed homogenization and necrosis of the entire epidermis, whereas in other parts vestiges of the basal layer and stratum Malpighii were seen with a normal horny layer. Investigations with uv irradiation are described. The patient's minimal erythema dose (MED), defined with a Xe arc, appeared to be within the normal limits. No abnormal reactions were noted on a single MED equivalent dose of uv irradiation, obtained by filtering the sunburn spectrum with a Schott WG 5 filter. The clinical and histological features suggested a phototoxic mechanism. In attempts to simulate this mechanism, 12 normal males were patch-tested with nalidixic acid. A uv dose, ranging between 15 to 60 MED equivalents, was applied using irradiations from a water-cooled mercury arc. No positive reactions were noted in these controls. (BBB)

49425 A SEARCH OF AGENTS PROTECTING AGAINST IRRADIATION. PART IX. SYNTHESIS OF SOME ASYMMETRIC DISULFIDES. **Tulecki, Jerzy; Dabrowski, Jerzy; Kalinowska-Torz, Jadwiga** (Katedra Technologii Chemicznej Srodkow Leczniczych Akademii Medycnej, Poznan, Poland). Diss. Pharm. Pharmacol., 18: 473-8(1966). (In Polish).

In continuation of studies on chemical agents protecting against irradiation, the reaction of sulfenyl chlorides with mercaptans was carried out. In an anhydrous medium, phthalimide-N-ethylsulfenyl chloride was condensed with thiosalicylic acid, 2-mercaptobenzothiazole, or furfurylmercaptan and o-carboxyphenylsulfenyl chloride with γ-phenylpropyl mercaptan. The asymmetric disulfides o-carboxyphenyl-2-phthalimidethyl, 2-benzothiazolyl-2-phthalimidethyl, 2-furfuryl-2-phthalimidethyl, and o-carboxyphenyl-γ-phenylpropyl disulfides were obtained. These compounds, which have not been described in the literature thus far, were submitted to biologic assay but the results are not reported here. The chemical reactions employed in the syntheses are outlined, and the physical and chemical properties of the products are given. (BBB)

49426 SIXTY-FIVE YEARS OF MEDICAL RADIOISOTOPE SCANNING (WHICH IS CLINICALLY REALLY ONLY ABOUT 5 YEARS OLD). **Brucer, Marshall.** Isotop. Radiat. Technol., 6: 109-13(Fall 1968).

A brief historical review of the use of radioisotope scanning in medicine is presented. The review begins with the use of natural radioactive materials at the start of the 20th century and continues through 1965 with the development of clinical equipment and procedures. (L.C.L.)

49427 ISOTOPE CISTERNOGRAPHY IN THE DIAGNOSIS AND FOLLOW-UP OF CEREBROSPINAL FLUID RHINORRHEA. **Di Chiro, Giovanni; Ommaya, Ayub K.; Ashburn, William L.; Briner, William H.** (National Inst. of Neurological Diseases and Blindness, Bethesda, Md.). J. Neurosurg., 28: 522-9(June 1968).

Use of ^{99m}Tc cisternography (pictorial scintiphotography of the head after introduction of a radioactive tracer into the subarachnoidal spaces) was demonstrated for the localization, demonstration of the cause, and follow-up of cerebrospinal fluid rhinorrhea. Originally, radioiodinated human serum albumin (RIHSA) was employed. An adult dose of 100 μCi, 0.2 to 0.4 ml (2 to 4 mg of albumin), was injected intrathecally. In children, 50 μCi (1 to 2 mg of albumin) was sufficient. Later, high specific activity ^{99m}Tc-human serum albumin (^{99m}Tc-HSA) was used. The method of preparing this compound consisted of an acid reduction of pertechnetate ion in the presence of iron and ascorbic acid prior to coupling to the protein. Nonorganically bound ^{99m}Tc was subsequently removed by ion exchange chromatography, and the product sterilized by membrane filtration. The high specific activity ^{99m}Tc-HSA dose employed for isotope cisternography was 2 mCi in adults and 1 mCi in children. Since the specific activity varied from 1.5 up to 12 mCi per mg, it was never necessary to inject more than 1 mg of albumin. Technetium-99m-albumin was found to be an ideal tracer for the isotope-cisternographic study of the CSF leaks. With 1 or 2 mCi, high count rates were ensured. The radiation exposure to the patient was negligible due to the short half-life (six hr) and the absence of β emission. In addition, the Anger type camera could be used efficiently with the 140-keV γ photon of the ^{99m}Tc. A disadvantage of ^{99m}Tc-HSA was that its short half-life made impractical studies at 24 to 48 hr (late scans). For this reason, a double tracer technique was sometimes used: high specific activity ^{99m}Tc-HSA for the early (up to 6-hr) and RIHSA for the late (24 to 48 to 72 hr) records. The ^{99m}Tc-pertechnetate ($^{99m}TcO_4^-$) ion cannot be used for isotope cisternography because it is resorbed locally at the site of the lumbar injection, and it is not transported with the cerebrospinal fluid. (BBB)

49428 "RADICAL" RADIOTHERAPY OF LYMPHOMAS. **Parker, Robert G.** (Univ. of Washington, Seattle). Radiol. Clin. N. Amer., 6: 71-82(Apr. 1968).

Radiobiologic principles applicable to the radiotherapy of lymphomas were discussed in an analysis of the optimal regimen for treating this disease. An optimum dose of radiation caused complete and permanent disappearance of tumors within the irradiated tissue volume, while causing minimal damage to normal structures. However, lymphomatous masses occasionally could not be controlled with high doses and complications followed modest doses. The marked, rapid radioresponsiveness of most lymphomas prompted use of low doses with consequent, unnecessarily frequent, local recurrences. The total dose probably was the major influence, but dose must be correlated with the standard parameters of radiation quality (RBE), overall time and pattern of application, and specific anatomical site and tissue volume treated. There was a gross correlation between tumor volume and dose required for its sterilization. Small, mobile glands were eradicated by 600 to 700 R, while large glands require 2000 to 3000 R. Although all types of lymphomas were radiosensitive, there was a spectrum of responsiveness from the very radiovulnerable follicular lymphoma to the less radiovulnerable reticulum cell sarcoma. (BBB)

49429 LOW INCIDENCE OF HYPOTHYROIDISM FOLLOWING RADIOIODINE THERAPY. **Feibush, Joseph S.; Sherman, Abraham A.** (Bronx-Lebanon Hospital Center, New York). N. Y. State J. Med., 68: 2158-60(Aug. 15, 1968).

Of 149 patients treated for hyperthyroidism using ^{131}I, 17 developed hypothyroidism, 12 within two years after therapy. The incidence of permanent hypothyroidism was 8.6 per cent. Radioactive iodine should be given in smaller dosage than formerly used, and it is suggested that additional radioiodine not be given before four months have elapsed following the initial dose. (auth)

49430 THERAPY OF RECURRENT CANCER OF THE NASOPHARYNX: VALUE OF INTERSTITIAL AND INTRACAVITARY RADIATION. **Hilaris, Basil S.; Lewis, John S.; Henschke, Ulrich K.** (Memorial Hospital for Cancer and Allied Diseases, New York). Arch. Otolaryngol., 87: 506-10(May 1968).

Use of implants of ^{125}I, ^{192}Ir, ^{198}Au, and ^{222}Rn and additional external 2-MeV x-ray therapy for locally recurrent nasopharyngeal cancer in 20 patients was described. For implantation, seeds

of ^{125}I were preferred because its low-energy γ radiation (27 keV) reduces the operator's radiation exposure almost to background levels. It also was possible to shield adjacent tissue easily. The longer half-life (60 days vs 3.85 days for ^{222}Rn and 2.7 days for ^{198}Au seeds) made implantation simpler and safer. The continuous low-dose radiation also had a more selective effect on the cancer cells. The two steps of the afterloading technique for a nasopharynx application were shown, namely the insertion of the unloaded applicator, carried out under local anesthesia and the afterloading with the radioactive sources, which was done after localization x-ray films were taken. The average survival of all patients was 15.9 ± 3.2 months. Three patients were still living without evidence of disease at 8, 36, and 45 months following retreatment. Interstitial and intracavitary radiation was a simple and effective means to provide worthwhile palliation and occasionally long survivals without significant side reactions. (BBB)

49431 ATHEROSCLEROSIS IN A DEFINED JAPANESE POPULATION: A CLINICOPATHOLOGIC APPRAISAL. **Rickert, Robert R.; Johnson, Kenneth G.; Kato, Hiroo; Yamamoto, Tsutomu; Yano, Katsuhiko (Atomic Bomb Casualty Commission, Hiroshima). Amer. J. Clin. Pathol., 49: 371-86(Mar. 1968).**

A quantitative study of atherosclerosis was made in a sample of 132 autopsy cases among the total ABCC sample of 100,000 persons who resided in the cities of Hiroshima and Nagasaki in 1950. These subjects were divided into groups according to their distance from the hypocenters at the time of the atomic bombing. Detailed study of this population has not revealed an association between exposure to radiation and the development of cerebral or cardiovascular disease. In general, atherosclerosis increased in severity with age and correlated positively with antecedent hypertension and with a concentration of cholesterol that exceeded 200 mg/100 ml of blood. The degree of atherosclerosis was greater in the aorta than in the coronary arteries. Cerebrovascular lesions were common, occurring in 41% of persons; they were the cause of death in 20%. Intracerebral hemorrhage caused death of ten of the 111 persons (9%). (BBB)

49432 POLYCYTHEMIA VERA: THERAPEUTIC USE OF BUSULFAN: COMPARISON WITH RADIOACTIVE PHOSPHORUS. **Jamra, Michel; Verrastro, Therezinha (Hospital das Clinicas, Sao Paulo, Brazil). Rev. Hosp. Clin. Fac. Med. Sao Paulo, 22: 241-66(1967). (In Portuguese).**

Serious side effects of radiophosphorus are reported, as occurring in the treatment of 26 patients. The intravenous doses varied from 2.7 to 8.2 mCi and the oral ones from 6.0 to 8.0 mCi. Four cases required only one dose, five two doses, two three doses, and one seven doses. Total doses varied from 3.7 to 19.1 mCi. A comparison was made between the results obtained with radiophosphorus and Busulfan. Clinical and hematologic responses occurred between the first and second month in the cases treated by ^{32}P or Busulfan. The induced remission with ^{32}P lasted up to 3rd and 38th month and with Busulfan up to the 3rd and the 28th month. During ^{32}P therapy some complications were noted. Two patients developed thrombocytopenic purpura and one, arterial thrombosis. Another was found to have acute leukemia after the 7th dose of ^{32}P. With Busulfan no complications such as thrombosis, hemorrhages, or development of other hematology disorders, including leukemia, were observed. The literature concerning the relation between polycythemia and leukemia and the possible role of radiation in leukemogenesis is reviewed. (BBB)

49433 USE OF ISOTOPES FOR DEMONSTRATION OF LESIONS IN JOINTS AND BONES AS AN AID IN DIFFERENTIAL DIAGNOSIS. **Strasser, Noel F.; Thrift, Chester B. J. Amer. Geriat. Soc., 16: 539-44(May 1968).**

The localization of ^{131}I and ^{85}Sr was studied in the joints and bones of patients with connective tissue disorders and metastatic cancer. Scintillation scans of the joints after intravenous injection of radioiodine in patients with rheumatoid arthritis, lupus, scleroderma, gout, and osteoarthritis demonstrated localization of radioactivity (correlated with the severity of the disorder) in the first 4 diseases, but not in osteoarthritis. The hands of a patient with severe rhematoid arthritis showed marked radioactivity in the joints that correlated well with the clinical findings. Such scintigrams may aid in estimating severity. Similar findings were obtained in cases of lupus, scleroderma, and gout. They are especially useful when roentgenographic and hematologic studies give negative results. In a patient with prostatic carcinoma and back pain, x-ray examination of the lumbar region failed to reveal metastases, whereas they were indicated by ^{85}Sr scanning of that area and confirmed at autopsy. (BBB)

49434 ILEOCYSTOPLASTY IN THE TREATMENT OF LATE POSTIRRADIATION BLADDER INJURY (CASE REPORT). **Musierowicz, Andrzej; Daszkiewicz, Edward (Regional Hospital, Warsaw). Pol. Tyg. Lek., 22: 1576-7(Oct. 1967). (In Polish).**

A 60-yr-old female patient, who at the age of 50 received x-ray treatment for uterine cervical cancer, complained of hematuria and dysuria, a painful incapacitating condition that had existed six months. Pathological and clinical findings revealed discolored abdominal skin and severe anemia; the urinary bladder had shrunk and was thickened on the left side. Surgery included partial resection of the bladder, ileocystoplasty, and ureteroileooncotomy, on the left side. The surgery revealed the following radiation effects: The mesenteric membrane, the entire left side of the bladder, and the ureteral outlet were scarred. They were hard and stiff but the right side of the bladder was normal. After excision of the radioinjured part of the bladder and partial removal of the ureter, the bladder was enlarged by means of a 15-cm graft of ileum to which the ureter was connected. Six weeks after surgery, the patient's incisions healed completely and, being able to pass urine more normally, she left the hospital. (BBB)

49435 VARIATIONS IN THE X-RAY SENSITIVITY OF SERRATIA MARCESCENS. **Tetteh, George Kwamena. Saskatoon, Saskatchewan, Univ. of Saskatchewan, 1967. 146p. Thesis.**

Experiments were performed to investigate the variation of x-radiosensitivity of Serratia marcescens with changes in relative humidity. Both aerobic and anoxic conditions as well as filter and aerosol techniques for drying were utilized. Also, the protective action of some chemicals, particularly i-inositol, was investigated using both drying techniques. One of the aims of the work was to develop a clearer understanding of the basic mechanisms by which x rays produce their effects on biological material. (Disser. Abstr.)

49436 EXPERIMENTAL DATA ON THE EFFECT OF CERTAIN VITAMINS AND VASOTROPHIC COMPOUNDS USED IN THE COURSE OF ACUTE RADIATION SICKNESS. **Alapbergenov, E. K. Tr. Kaz. Nauch.-Issled. Inst. Onkol. Radiol., 1: 366-71(1965). (In Russian).**

Several compounds were tested, both prophylactically and therapeutically, that possessed radioprotective properties to various degrees in rats x-irradaited with 900 R. With the therapeutic use of leucodelphinidin, acute radiation sickness assumed a milder course: survival time of the rats lengthened and the rate of survival attained eight to ten percent vs the 100% mortality rate of controls. Ascorbic acid, vicasol, serotonin, and reserpine slightly lengthened the survival time of irradiated animals. Pentamine negatively affected the course of the acute radiation sickness. Reserpine plus vitamin C treatment noticeably increased the resistance of capillary vessels of rats during acute radiation sickness. Under the action of the various compounds, the resorption rate of ^{32}P through the skin underwent the following fluctuations: vicasol, ascorbic acid, and pentamine failed to have a positive effect on the increased permeability of capillaries in irradiated animals. Serotonin stabilized the permeability, but failed to increase it after irradiation. Reserpine as a liberator of serotonin sharply decreased vascular permeability three to ten days following irradiation. Among the compounds studied, only leucodelphinidin noticeably normalized the permeability of vessels in irradiated animals. The prophylactic use of all compounds, unlike their therapeutic administration, exerted a negative effect on the course of the acute radiation sickness in rats. The results indicate that only the reserpine-vitamin preparation leucodelphinidin rendered a therapeutic antiradiation action. (BBB)

49437 RELATIONSHIP BETWEEN THE CURATIVE ACTION OF THE BONE MARROW TRANSFUSION AND THE DEGREE OF GENETIC AFFINITY OF THE DONOR TO THE RECIPIENT. **Muksinova, K. N.; Klyzhuk, K. N. (Kharkov Inst. of Radiology). Med. Radiol., 13: No. 7, 11-15(July 1968). (In Russian).**

Data are presented on the effectiveness of bone marrow therapy following supralethal γ irradiation of dogs. Affinity depends largely upon genetic affinity relation between the donor and the recipient. Animals exposed to the effect of radiation in doses of 1000 and 1200 R had at the 3rd day post-irradiation bone marrow cells of donors belonging to the same and different litters introduced into the organism at the rate of 0.5×10^9 per 1 kg of body weight. Administration of a allogenic bone marrow was shown to increase the survival rate and lengthen the life span of dogs and also to cause a more intense restoration of the bone marrow hemopoiesis and peripheral blood characteristics to a far greater extent than was the case with unrelated bone marrow. The ability of hemopoietic cells to undergo lymphoid transformation proved less marked following introduction of bone marrow obtained from donors of the same litter. (auth)

49438 RADIOPROTECTION OF CHROMOSOMES OF HUMAN MEDULLARY CELLS IN VITRO. Cardini, G.; Riggio, G.; Pegoraro, M.; Galimberti, A.; Gasparini, C. Radiobiol. Radioter. Fis. Med., 22: 371-5(Nov.-Dec. 1967). (In Italian).

The radioprotective effects of some amino-acids (methionine, glutamic acid, phenylalanin, tryptophan) on the chromosomes of human cells irradiated in vitro were studied. Cultures radioprotected with methionine showed a remarkable reduction in chromosomic fragmentation, while the other amino acids studied displayed no radioprotective action. (auth)

49439 EXPERIMENTAL TREATMENT OF LATE POSTIRRADIATION ULCERATIONS BY NONSPECIFIC STIMULATION OF THE RETICULO-ENDOTHELIAL SYSTEM. Dobrek, Zbigniew (Inst. of General Oncology, Gliwice, Poland). Pol. Tyg. Lek., 15: 558-9(1968). (In Polish).

The polysaccharide zymosan, produced from baker's yeast and suspended in physiological salt solution, was administered to five patients intravenously every 2nd day in single doses of 1 mg/Kg as a therapy for radioinduced ulcerations that developed after Ra and x-ray treatments of neoplasms. Good results are reported for patients without additional neoplastic occurrences. (BBB) (TSS)

49440 DENTAL RADIATION: FACTS VS. FANCY. Hyman, Milton; Pentel, Leon (New York Univ. Coll. of Dentistry, N. Y.). N. Y. J. Dent., 38: 126(Apr. 1968).

Hazards of dental radiography to patients are reviewed. One estimate of the total exposure to a patient's head in taking a 16-film dental x-ray series at 65 KVp, 10 mA, 8-in target distance with high-speed (Group D) film is 3.0 to 5.0 R, or about $^{1}/_{900}$th of the dose in radiotherapy. Birth defects may be a possible result of direct fetal irradiation, but it is impossible for a dental x-ray exposure to be made that would result in fetal exposure to the direct beam. Secondary radiation could reach the fetus, but this could be overcome by draping the patient with a leaded apron. Dental radiography has been condemned by some because of gonadal exposure, yet the gonadal exposure of 0.3 mR. This is the daily dose received from background radiation in daily life. This small amount of radiation could also be eliminated by using a leaded apron. With the knowledge of the effect of radiation on tissues, a realistic perspective has been reached with respect to acceptable x-ray practices. Now good practice dictates that the number of x-ray exposures be kept to a minimum, and that every exposure be necessary. (BBB)

49441 LINEAR ACCELERATOR IN THE TREATMENT OF CERVICAL CANCER: A DECADE OF EXPERIENCE. McLennan, Charles E.; McLennan, Margaret T.; Bagshaw, Malcolm A. (Stanford Univ., Palo Alto, Calif.). Trans. Pac. Coast Obstet. Gynecol. Soc., 34: 93-8(1966).

Injury resulting from supervoltage x-ray therapy, particularly to the colon, is reported in a series of 168 patients treated for cervical cancer with the Standford medical linear accelerator. Incidence of radiation damage to bowel, particularly the rectosigmoid, was distressingly high and has not been reduced in recent years by changing from rotational therapy to paired parallel opposed rectangular fields. Stages I and II were treated first by Ra application, using three 10-mg Ra sources in the intrauterine tandem and a 20-mg source in each colpostat. This was applied for about 50 hr, or until a calculated dose of 3500 to 4000 rad was delivered. A second application was given seven to 10 days later. Several days following the second application, full pelvic external irradiation with the linear accelerator was started utilizing paired parallel opposed rectangular fields. In the past four yr, about $^{3}/_{4}$ of the patients reported some degree of diarrhea during treatment, compared with an incidence of 84% in the first 100 patients. Six of the 100 women treated earlier required either a colostomy or resection of an intestinal segment damaged by radiation. Of the 68 treated in the period 1962 to 1965, eight (12%) required colostomies, two were hospitalized for conservative management of intestinal obstructions, and four were treated for severe late proctitis. (BBB)

49442 PHYSICAL FACTORS IN THE RADIOTHERAPY WITH ELECTROMAGNETIC RADIATION. Fava, G. (Univ., Milan. Istituto Nazionale per lo Studio e la Cura dei Tumori, Milan). Radiol. Med., 54: 329-40(Apr. 1968). (In Italian).

The physical aspects of the electromagnetic ionizing radiations used in radiotherapy are considered. The interaction of radiations with substances from the microscopic and macroscopic points of view are examined as a basis for the choice of the radiation type suitable for correct therapy. After recalling the behavior of the photoelectric effect, the Compton effect, and of pairs production as to the increasing of energy, the author examines the effects of lateral diffusion, of back scattering, and of differential absorption that derive from them when a beam of photons crosses a non-homogeneous medium. (auth)

49443 ^{113m}In DIETHYLTRIAMINOPENTACETIC ACID (DTPA): A NEW RADIOPHARMACEUTICAL FOR BRAIN SCANNING. Clements, John P.; Wagner, H. N. Jr.; Stern, H. S.; Goodwin, David A. (Johns Hopkins Medical Institutions, Baltimore). Amer. J. Roentgenol., Radium Ther. Nucl. Med., 104: 139-44 (Sept. 1968).

A new radiopharmaceutical, ^{113m}In-diethyltriaminopentacetic acid (DTPA) as a brain scanning agent was developed. ^{113m}In, which has a half-life of 1.7 hrs, is obtained in ionic, carrier-free form by elution of a ^{113}Sn (tin) generator system. The chelate ^{113m}In-DTPA can be prepared simply and rapidly. Satisfactory tumor : brain concentration ratios were found in experimental tumors in mice and in brain tumors in man. Over 400 brain scannings were performed with satisfactory results and without untoward effects. In 87 patients, brain scannings with both ^{99m}Tc-pertechnetate and ^{113m}In-DTPA were carried out. The images were essentially the same with both agents. ^{113m}In-DTPA was found to be comparable to ^{99m}Tc-pertechnetate in the detection and characterization of intracranial lesions. The long half-life of 118 days of the parent ^{113}Sn is an advantage since replenishment is required only at six month intervals rather than weekly as in the case of the ^{99}Mo/^{99m}Tc generator. (auth)

49444 A METHOD OF PRESENTING DATA IN SCINTILLOGRAPHY: THE COLOURED ISO-CHART. Sannazzari, G. L.; Negri, G. L.; Marini, D. (Univ., Turin). Minerva Radiol., 13: 151-5(Mar. 1968). (In Italian).

A semiquantitative method of presenting scintillography data using a colored isochart is described. The use of four colors (red, violet, green, and yellow) supplies scans made up of areas each subdivided by four marks (1, 2, 3, and 4). In this way isocount curves can be plotted on the scintillogram separating areas of radioactivity different one from the other by $^{1}/_{16}$ of maximum value. (auth)

49445 SCINTIGRAPHIC STUDY WITH ^{85}Sr OF THE METASTATIC ALTERATIONS OF THE SKELETON. Zucali, R.; Uslenghi (Univ., Milan. Istituto Nazionale per lo Studio e la Cura dei Tumori, Milan). Nunt. Radiol., 33: 399-413(Apr. 1967). (In Italian).

Statistics are presented on 41 patients that confirm the usefulness of diagnostic research with ^{85}Sr in the study of neoplastic alterations of the skeleton and, in particular, of metastatic ones. In some cases it was possible to diagnose the presence of metastases in the skeleton that were not demonstrable radiologically. Owing to the possible damages to the bone and to the marrow caused by the γ radiations of the ^{85}Sr, the technique should be limited to the study of skeleton alterations, the malignant nature of which is known or suspected, only when the radiological examination does not appear sufficient to solve all the diagnostic problems. (auth)

49446 FERRIC HYDROXIDE PARTICLES LABELED WITH INDIUM ^{113m}In FOR LUNG SCANNING. Goodwin, David A.; Stern, Howard S.; Wagner, Henry N. Jr. (Johns Hopkins Medical Institutions, Baltimore). J. Amer. Med. Ass., 206: 339-43(Oct. 7, 1968).

Regional pulmonary arterial blood flow may be effectively measured by the distribution of radioactive particles in the lung following an intravenous injection. The original method required use of iodinated serum albumin, aggregated (MAA 131 [Human]), which limited the total amount of injected radioactivity to a maximum of about 300 μc. To increase the photon output while decreasing the radiation-absorbed dose, we labeled iron hydroxide aggregates with the short-lived nuclide, ^{113m}In. This isotope may be obtained economically in the carrier-free state from a tin ^{113}Sn–^{113m}In generator in the clinical radioisotope laboratory. The preparation of the particles takes 15 minutes, and they may be autoclaved prior to injection. These aggregates have suitable physical and biological characteristics for lung scanning, and permit better images in a shorter period of time than iodinated ^{131}I serum albumin, aggregated. (auth)

49447 TISSUE AND TUMOR CONCENTRATIONS OF ^{99m}Tc AS PERTECHNETATE. Mishkin, Fred S.; Reese, Isaac C. (Indiana Univ. Medical Center, Indianapolis). Amer. J. Roentgenol., Radium Ther. Nucl. Med., 104: 145-9(Sept. 1968).

Measurement of tissue levels of technetium-99m was performed in patients who had a meningioma, chronic subdural hematoma, and fibrous dysplasia of the skull. Technetium-99m was shown to concentrate in the brain tumor to a level twice that of blood. Technetium-99m is not specific for brain tumors, and concentrates in lesions of bone, but to a much less degree than strontium-85. Thus it is worthwhile repeating a positive technetium-99m scan with strontium-85 in a patient suspected of having a bone lesion, in order to distinguish brain from bone lesions. The peripheral rim of activity seen in the technetium-

99m brain scan can be remarkably diminished by external pressure, and is thought to be accounted for in great part by the subcutaneous tissues, as well as the great venous sinuses of the dura. (auth)

49448 ANATOMIC-RADIOGRAPHIC CONSIDERATIONS OF NEUROBLASTOMAS. Matronola, V.; Marcorelli, E. (Univ., Rome). Nunt. Radiol., 33: 605-24(June 1967). (In Italian).

The diagnosis of neuroblastoma of the sympathetic nervous system is discussed, with emphasis on the use of radioisotope scanning as a supplement to radiographic examinations. Results using ^{198}Au and ^{85}Sr as scanning agents are reported. (C.H.)

49449 MORPHOLOGICAL CHANGES IN THE REGIONAL LYMPH NODES IN PATIENTS WITH MILK-DUCT CANCER IN INTRATISSULAR ADMINISTRATION OF ^{198}Au. Badmaeva, V. V.; Morozov, A. P. (Moscow Oncological Inst.). Med. Radiol., 13: No. 8, 26-34(Aug. 1968). (In Russian).

Results are reported from dosimetric and histological investigations of the lymph nodes of different regional groups in 113 patients suffering from milk-duct cancer following treatment with ^{198}Au. The percentage of isotope accumulation in different regional groups was estimated. It was found that in the lymph nodes, in complete or massive replacement of the lymphoid tissue by the neoplasm ^{198}Au did not accumulate, in view of which diffuse metastatic foci could not be irradiated with beta particles. In the lymph nodes with micrometastases and emboli the regressive changes of neoplastic cells under the effect of beta particles were studied. The absorbed dose reached 25000 to 75000 rad. In the lymph nodes free of metastases there was an irregular spread of colloidal radiogold, causing the focal nature of radiation changes. In doses of 125,000 rad and higher, necrosis of lymph nodes and lymphatic tract caused a picture of their radiation exclusion. (auth)

49450 GASTRIC ULCER IN PATIENTS IRRADIATED WITH TELECOBALT THERAPY ON LUMBO-AORTIC LYMPHATIC CHAIN. Taddei, L.; Aulisi, A. (Univ., Florence). Nunt. Radiol., 33: 517-31(May 1967). (In Italian).

Three cases of gastric ulcers that appeared a short time following γ-telecobaltotherapy, given after orchiectomy for seminoma, are reported. Two of the three patients were treated on the periaortic lymph glands through unique anterior field and the third was irradiated on the same focus through three convergent fields (one anterior and two posterior oblique). All three patients received on the periaortic lymph glands a dose of 1000 R during two to three consecutive sittings through the anterior field; in one, five months after the end of a previous treatment (3000 R/foc through three fields), in the other two at the beginning of telecobaltotherapy (4000 R/foc with 26/30 days). The literature on the subject is reviewed and observations on the patients are discussed. (auth)

49451 FURTHER EXPERIENCE WITH POST-IRRADIATION BONE SARCOMA. Tefft, M. (Children's Hospital, Boston). Ann. Radiol., 11: R485-90(1968).

A review of the records of the x ray Therapy Division at the Children's Hospital Medical Center of Boston revealed cases of bone sarcoma that occurred in normal bone included in the fields of radiation therapy. Five such patients were noted who had undergone irradiation for soft tissue neoplasms and developed, at some later date, either osteogenic or chondrosarcoma of bone included in the field of x ray therapy. The histologic types of such sarcomatous changes and the anatomic areas of involvement are discussed in relation to the areas undergoing irradiation and to the doses delivered. The need for very careful follow-up evaluation of all children undergoing initial irradiation is stressed. (auth)

49452 TELECOBALT THERAPY OF LYMPH NODE METASTASES OF THE GERMINAL TUMORS OF THE TESTICLE. Clementi, T.; Spina, C. (Univ., Rome). Nunt. Radiol., 33: 309-30(Mar. 1967). (In Italian).

Irradiation techniques are described for telegammatherapy with ^{60}Co for the treatment of lymph node metastases of germinal tumors of the testicle. The results obtained using the technique are reported. (auth) (TSS)

49453 OSTEOSARCOMAS OF IRRADIATED INFANTS. PRESENTATION OF A CASE. Laurent, Y.; Detroux, J.; Lebrun, J.; Rosillon, J. (Clinique Cesar de Paepe, Brussels. Institut Sainte-Elisabeth, Brussels. Institut Jules Bordet, Brussels). J. Belge Radiol., 51: 112-16(1968). (In French).

Clinical and radiological data are reported for a case of osteosarcoma of the humerus in a 16 yr old girl who was treated for a cutaneous angioma of the axilla using contact radium irradiation. The period of irradiation extended from the age of six months to four yrs. (auth)

49454 HIGH ENERGY THERAPY FOR RECURRENCES OF CARCINOMA OF THE CERVIX UTERI. Nieminen, Usko; Kotsalo, Kustaa (Univ., Helsinki). Ann. Chir. Gynaecol. Fenn., 55: 313-16(1966).

A total of 97 patients with cervical carcinoma recurrences were treated with a 400 μCi ^{60}Co (74 patients), a 3000-Ci Gammatron (19 patients), 35-MeV betatron (3 patients), and Ra (1 patient). The patients tolerated the high energy therapy fairly well with the exception of the few cases in which treatment had to be interrupted for one or two weeks. The main change in the blood picture was leukopenia in five patients. Radiotherapy was usually continued provided the leukocyte count did not drop below 2500. In all, 25 patients developed anemia during therapy. Disturbances of bowel function occurred during and after therapy in 16 cases and urinary bladder distress in 18 cases. (BBB)

49455 VARIATION OF RADIATION SENSITIVITY OF BACTERIA FED TETRAHYMENA PYRIFORMIS DURING THE GROWTH CYCLE AND FACTORS RELATED TO ITS ORIGIN. Calkins, J. (Univ. of Kentucky, Lexington). Photochem. Photobiol., 8: 115-29(Aug. 1968).

Tetrahymena pyriformis shows a cyclic variation of sensitivity (for lethality) to uv light while the response to x rays is almost constant throughout the growth (division to division) cycle. It is demonstrated in this paper, and elsewhere, that survival of caffeine-treated animals is higher after higher doses than after the lower doses of radiation; such a response indicates that the increased radiation dose induces a resistant state not existing at lower doses. Response of synchronized animals to postirradiation treatment with caffeine is interpreted as indicating that recovery from the lethal effect of radiation has two components as previously postulated: (1) a caffeine-sensitive recovery system (termed the "N" system) and, (2) an activated recovery capacity (termed the "T" system) which is less sensitive to caffeine. The maximum activated (T) system repair capacity only equals the repair capacity of the (N) non-activated system for x-ray induced lesions and, since the N system does not seem to show a cyclic variation of effectiveness@or x-ray induced lesions, the x-ray survival remains constant throughout the growth cycle. The repair capacity of the activated (T) repair system is, throughout most of the cycle and especially during the S period, much greater than that of the N system for uv induced lesions. Thus the uv response varies in a manner largely dependent upon the capacity of the activated system and the fraction of the population showing the activated response; in G2, a time when the activated repair system is rather ineffective, the non-activated (N) system appears to become unusually efficient in the repair of uv-induced lesions. (auth)

49456 METHOD OF TREATING SCANNOGRAMS FOR CONTRASTING. Lyutsko, A. M.; Soshin, L. D. (Belorussian State Univ., Minsk). Med. Radiol., 13: No. 3, 51-4(1968). (In Russian).

A method is proposed for processing for contrasting hatched scannograms of the type obtained on the Hungarian scanner MB-7101. This method facilitates the interpretation of scannograms, especially in "obscure" cases. (auth)

49457 DECREASED SURVIVAL RESULTING FROM LIQUID-HOLDING OF U.V.-IRRADIATED ESCHERICHIA COLI C AND SCHIZOSACCHAROMYCES POMBE. Harm, W.; Haefner, K. (Southwest Center for Advanced Studies, Dallas). Contract AT(40-1)-3601. Photochem. Photobiol., 8: 179-92(Sept. 1968). (ORO-3601-3).

Ultraviolet-irradiated cells of E. coli C and of haploid wild type yeast Schizosaccharomyces pombe, held in buffer at 22°-25°C for various periods of time prior to plating, show a lower survival than those plated immediately after irradiation. This "negative liquid-holding effect" (NLHE) contrasts "liquid-holding recovery" (LHR), found in a number of other E. coli strains and in Saccharomyces cerevisiae. NLHE was observed at all uv doses tested. The effect is maximal at holding temperatures in the range 25-30°C, it is very small at 5°C and (in E. coli C) at 44°C. NLHE and LHR resemble each other in several respects. In E. coli both effects are inhibitable by the dark repair inhibitors acriflavine, caffeine and potassium cyanide. They do not occur in nutrient broth, and they are much reduced if the irradiated cells were illuminated with photoreactivating light before holding. NLHE in S. pombe shows characteristics similar to those observed in E. coli C. Mutations leading to increased uv sensitivity in E. coli C and S. pombe can alter the liquid-holding response so that LHR is observed. Tetrad analysis of crosses between uv-sensitive and uv-resistant S. pombe strains indicates that a single chromosome region can control both uv sensitivity and liquid-holding response. Several possibilities explaining NLHE are discussed. From current knowledge about dark repair processes and from the simi-

larities between NLHE and LHR in E. coli it seems likely that the two effects reflect slight changes in the efficiency of dark repair. (auth)

49458 FUNCTIONAL INTEGRITY OF THE ADRENAL GLAND AND RADIATION SICKNESS. Tkacheva, G. A. (Inst. of Medical Radiology, Erevan). Med. Radiol., 13: No. 2, 21-5(1968). (In Russian).

The degree of adrenaline influence on rats by the adrenal cortex was studied and the ratio between the corticosteroid level and catecholamine content was determined to obtain the maximal antiradiation effect. Disturbance of the corticomedullary integrity of the adrenal gland was achieved by means of adrenalectomy (total and partial), demedullation and adrenaline or hydrocortisone injection. A dose of 900 R γ radiation was employed. It was found that bilateral adrenalectomy, demedullation and cortisone therapy reduce the survival of irradiated animals. Adrenaline exerts a distinct protective effect. (auth)

49459 PROTECTIVE ACTION OF CERTAIN LOW-MOLECULAR ORGANIC COMPOUNDS AGAINST RADIATION INJURY OF VICIA FABA SPROUTS. Semerdzhyan, S. P.; Avakyan, Ts. M.; Vartanyan, S. A.; Oganesyan, Dzh. O. Biol. Zh. Arm., 20: 9-14(1967). (In Russian).

Preliminary results are presented of tests on the radiation protection properties of several low-molecular weight organic compounds. Selected seeds of Vicia faba, variety Khertsfre, were soaked one day, and grown in moist sand for three days. The sprouts were treated with 20 mg/l and 100 mg/l solutions of 4-hydroxy-2, 2-dimethyltetrahydropyran-4-carboxylic acid (A), beta, beta-dimethyldivinylketone (B), or commercial carbamide and methylvinylketone (C). Treatment was before, or before and after irradiation at 55 R/min. Total dosage was 200 R. Treatment of the sprouts with the solutions had little effect on the mitotic activity of the cells, but irradiation reduced mitotic activity considerably. Treatment with 20 mg/l solutions, regardless of time of treatment, reduced cell injury and before and after treatment with the 100 mg/l solutions also had positive effects. The protectors themselves did not inhibit cell division or cause chromosome rearrangement, but 200-R irradiation resulted in severe injury. Treatment with solutions of the protectors A and C significantly reduced the number of cells with chromosome breakage; protection by compound B was noted, but was not as great. The antiradiation effect of these compounds is specific—C reduced the number of chromosome fragments formed, while A and B reduced the number of chromosome bridges and the number of points in the anaphase and telophase. Further study is needed to detail the characteristics of the antiradiation properties of these compounds and to explain the nature of their action. (JPRS)

49460 SERIAL BRAIN SCANNING USING ^{99m}Te IN PATIENTS WITH CEREBRAL INFARCTION. Molinari, G. F.; Pircher, F.; Heyman, A. (Duke Medical Center, Durham, N. C.). Trans. Amer. Neurol. Ass., 91: 309-11(1966).

Multiple scans during the course of the patient's illness are usually avoided largely because of the risk of radiation exposure associated with the long half-life of the radioisotopes used in these studies. The relatively short half-life and low radiation exposure with ^{99m}Tc, a γ-emitting isotope, now permit serial scans during the development and resolution of the cerebral infarction. Studies were conducted in 20 patients. Each patient received an intravenous injection of 4 to 10 mCi ^{99m}Tc. A lateral scan of the involved cerebral hemisphere was taken within a few minutes, followed usually by a repeat scan of the same side 45 minutes later and by a lateral scan of the other cerebral hemispheres as well as anterior and posterior scans. Count rates ranging from 6,000 to 30,000 cpm were obtained. Abnormal areas of increased radioactivity were observed in only 4 patients scanned within 7 days after the onset of neurologic symptoms. Incidence of abnormal scans increased to 67% when the scans were repeated in the second to third week after onset of infarction. Patterns of isotope localization are described. An extensive, irregularly shaped area of abnormal radioactivity contrasting markedly from the surrounding brain tissues was observed in 8 patients. The pattern of radioisotope localization in cerebral infarction often had a characteristic appearance, but in many instances could not be differentiated from other intracranial lesions such as neoplasms or subdural hematoma. (BBB)

49461 RADIOPROTECTIVE ACTION OF CYSTAMINE AT THE YEAST CELL MEMBRANE. Stuart, Bruce Owen; Stannard, J. N. (Univ. of Rochester, New York). Radiat. Res., 34: 459-72(1968). (UR-49-822).

The dithiol, cystamine, affords marked protection against the effects of x irradiation on potassium leakage from baker's yeast cells. Little protection is afforded under the same conditions against irradiation-induced inhibition of colony formation. Analysis of the binding of cystamine to the cell surface shows that the agent does not penetrate to the cell interior. This is considered to account for the lack of protection of cell growth mechanisms. Furthermore, the cystamine can be largely displaced from the cell surface by competition with the bivalent cations, manganous and calcium. Yet, the radioprotection against changes in K^+ leakage rates was identical whether 99% or only 30% of the binding sites were occupied by cystamine. This suggests that its mode of action may be mediated largely by radical scavenging in the medium or immediate environs of the membrane, and establishes that binding is not essential for radioprotection in this system. (auth)

49462 OXYGEN EFFECT IN BACTERIAL CELLS IRRADIATED WITH HIGH-INTENSITY PULSED ELECTRONS. Epp, Edward R.; Weiss, Herbert; Santomasso, Ann (Sloan-Kettering Inst. for Cancer Research, New York). Radiat. Res., 34: 320-5(1968).

The oxygen effect has been studies in Escherichia coli B/r irradiated with high-intensity pulsed electrons as a function of oxygen concentration. The dose to the cells was delivered in single pulses of time duration 30 nanoseconds. As was observed previously at low oxygen concentrations, survival measured under pulsed conditions for higher concentrations is greatly different from that obtained under relatively low-dose-rate conditions. Typically, the survival curve for cells which are pulse-irradiated follows the oxygenated response to a point dependent on concentration before breaking away to parallel the slope of the survival curve measured under conditions of pure nitrogen. A plot of the "break-point dose" versus oxygen concentration appears linear. The data can be interpreted as further support for a hypothesis based on oxygen depletion within the cell by the first part of the electron pulse previously proposed for Serratia marcescens pulse-irradiated at low oxygen concentrations. The data can also provide a basis for the direct measurement of oxygen diffusion time in cells. (auth)

49463 ESR STUDIES OF SPIN TRANSFER IN IRRADIATED NUCLEIC ACID-CYSTEAMINE SYSTEMS. Milvy, Paul; Pullman, Ira (Sloan-Kettering Inst., New York). Radiat. Res., 34: 265-86(1968).

Some aspects of the mechanism of protection of irradiated DNA by cysteamine were investigated by using ESR spectroscopy. Solutions of nucleic acids and their constituents with 10% by weight of cysteamine hydrochloride were dried, evacuated, and irradiated with x rays at 100°K. The ESR spectra of the samples were studied as a function of increasing annealing temperature. In the native DNA system the intensity of the organosulfur radical at about room temperature reached thirteen times that expected from the cysteamine present. Similarly, high transfer ratios were observed for denatured DNA, dTMP, dUMP, ribose-5′-phosphate, and deoxyribose-5′-phosphate. About one quarter of this transfer ratio was found for RNA and UMP. Very little or no transfer was found for thymidine, thymine, dAMP, dGMP, dCMP, 5-methyl dCMP, and deoxyribose. The organosulfur spectrum disappeared at the melting point of cysteamine hydrochloride in all samples in which it developed except for native DNA, where the signal persisted at least to 373°K. It is postulated that the cysteamine binds through its amino group to the phosphate group in the nucleotide and that transfer of spins to the sulfur atom is facilitated by a 2,4-diketo structure in the base as present in thymine and uracil and by a deoxyribose sugar structure. (auth)

49464 PROTECTIVE EFFECT OF GLUTATHIONE AGAINST X RADIATION. Kawase, Etsuro (Okayama Univ. Medical School, Japan). Okayama Igakkai Zasshi, 79: 417-24(June 1967). (In Japanese).

The radioprotective effects of glutathione against x radiation in mice and rabbits were studied. The minimal dose of glutathione to show a protective effect was 100 mg/Kg or 2.5 mg/mouse. From the survival rate of these animals and from changes in the body weight and in the blood picture of rabbits, it was shown that a considerably smaller dose of glutathione injected intravenously was as effective as the doses given subcutaneously or intraperitoneally. Although no protection was noted when glutathione was injected in whole-body irradiated rabbits just before a single large x-ray dose (1000 R), a considerable protective effect could be obtained with the doses of 100 mg/Kg injected into the ear vein for several days just before 100 R/day chronic irradiation doses. This was verified by the changes observed in the numbers of lymphocytes, total leukocytes, and erythrocytes. (TSS) (BBB)

49465 TREATMENT OF X-RAY INJURY OF THE SKIN WITH PREDNISONE. Zschunke, E.; Behrbohm, P. (Deutsches Zen-

tralinstitut fuer Arbeitsmedizin, Berlin). Dermatol. Wochenschr., 152: 1417-21(Dec. 17, 1966). (In German).

At 24 hr following inadvertent exposure of the hands to 20- or 50-KV x ray during the course of cleaning an x-ray tube, a 24-yr-old man noted reddening and swelling. It was estimated that the dose to the fingers was 3900 R, and that the rest of the hands received 1000 R. Cleansing salve was applied, but 24 hr later the fingers became painful, and blisters appeared. On the fifth day after irradiation the blisters were opened and bandaged. The blood cell picture and sternal marrow cells were normal 14 days after irradiation. The skin of the hands was swollen, taut, and discolored a violet to brownish red color. Ulcers were present where the blisters had been located previously. These were subepidermal, single chambered blisters, each about the size of a pigeon egg on each thumb, which contained a clear liquid. Therapy consisted of 50 mg of prednisone daily for one week, followed by gradual reduction to 7.5 mg daily by the beginning of the sixth week of treatment. During the first treatment week two oxytetracycline capsules were given daily, along with pain relieving drugs and vitamins. In addition, a 0.5% prednisone salve and hand soaks were given during the first two weeks, followed later with dry bandages. (BBB)

49466 THE PRACTICAL APPLICATION OF SCINTIGRAPHY. [PART IV]. Gahr, H. Roentgenpraxis, 21: 101-6(May 1968). (In German).

Two methods of spleen scintigraphy are reported. The advantages and disadvantages of each are discussed and compared. Both methods yield data on the size, location, and morphology of the organ. One method uses ^{51}Cr-labeled erythrocytes as the tracer. The use of ^{197}Hg-labeled bromomercury hydroxypropane permits the scintigraphic representation of the kidneys after the spleen scanning. Both methods represent a significant addition to the differential diagnosis of diseases of the left upper abdomen and the hematopoietic system. (tr-auth)

Radiation Effects on Animals

Refer also to abstracts 49186, 49189, 49218–49221, 49225, 49226, 49230, 49233, 49234, 49236, 49240–49242, 49250, 49254, 49259, 49260, 49272–49274, 49276, 49277, 49279–49284, 49294, 49298, 49315, 49318, 49322, 49325, 49328, 49332, 49334, 49335, 49355, 49363, 49368, 49376, 49381–49387, 49390, 49396, 49412, 49413, 49419, 49421–49424, 49429, 49436, 49437, 49439, 49441, 49449–49451, 49453, 49454, 49458, 49464, 49641, 49652, 49654, 49655, and 50883.

49467 (CONF-680410) THE PROCEEDINGS OF A SYMPOSIUM ON DOSE RATE IN MAMMALIAN RADIATION BIOLOGY, APRIL 29–MAY 1, 1968. Brown, D. G.; Cragle, R. G.; Noonan, T. R. (eds.) (UT-AEC Agricultural Research Lab., Oak Ridge, Tenn.). July 12, 1968. 450p. Dep. CFSTI.

Separate abstracts were prepared for nineteen of the twenty-four papers presented. Four were previously included in NSA. For abstract numbers of these papers see CONF-680410 in the report number index. One paper appeared in abstract form in the conference proceedings and therefore was not processed for NSA. (B.G.D.)

For abstracts of individual papers see: 49175, 49378, 49379, and 49468–49483.

49468 (CONF-680410–, pp 2,1-27) FRACTIONATION AND PROTRACTION FACTORS AND THE LATE EFFECTS OF RADIATION IN SMALL MAMMALS. Grahn, Douglas; Sacher, George A. (Argonne National Lab., Ill.).

Problems in the interpretation of data from fractionation experiments, in the development of viable hypotheses involving the infinite array of fractionation variables, and in the design of effective experiments to test the predictive value of such hypotheses have been among the more difficult ones of mammalian radiation biology. Although this review limits itself principally to the life-shortening effects of fractionated and protracted exposure regimes, it attempts to integrate a wide array of data into a coherent picture of chronic radiation injury. The evaluation of split dose studies emphasizes the nature of one problem—measures of short-term recovery have no simple relation to life time measures of injury. For example, split-dose regimes suggest recovery rates of 10 to 50% per day for acute injury yet little or no recovery is noted in terms of chronic injury. Briefly fractionated and terminated exposures are generally consistent with this observation. Protraction periods of 100 days or more produce a shift in long-term response which indicates equilibration between injury and recovery. This is evoked when dose fractions are below some level that continues to suppress hematopoietic recovery; the evidence suggests this is not a step-function in dose, but a continuum. The reduced effectiveness of the more protracted regimes is a characteristic of low LET x and γ radiations; the same effect is not seen under neutron irradiation. This seems to account for the rather sudden shift in RBE values from 2-5 to 10-20 when comparing acute with chronic end-points. The base-line condition in fractionation and protraction is daily exposure for the duration of life. The minimum effect per rad is observed. This regime also offers an excellent means of interspecies comparison for prediction of long-term effects. Finally, some discussion of wasted radiation, residual dose, and single versus multiple recovery constants will be made along with a plea to avoid the simplistic. The cumulative evidence suggests that the simple generalizations, while experimentally attractive, are not biologically realistic and may even act as deterrents to a more integrative study. (auth)

49469 (CONF-680410–, pp 3,1-12) STEADY STATE UNDER CONTINUOUS IRRADIATION. Lamerton, L. F.; Courtenay, V. Doreen (Instute of Cancer Research, Surrey, England).

The capacity of a tissue to maintain a steady or near-steady state of cell population and function under continuous irradiation for prolonged periods will depend on a number of factors, including the following: the extent of any intracellular accumulation of radiation injury, the cell survival characteristics under continuous irradiation, the allowable reduction in cell population or cell output before collapse of tissue or vital function, and the nature and extent of adaptive processes or of changes in response that can occur in the system under continuous irradiation. The operation of these factors will be discussed in the light of experimental data on in vitro and in vivo mammalian systems, with an examination of how far they may explain the very different susceptibilities to continuous radiation exposure exhibited by different tissues and species. (auth)

49470 (CONF-680410–, pp 4,1-21) DOSE-RATE STUDIES WITH SHEEP AND SWINE. Ainsworth, E. J.; Page, N. P.; Taylor, J. F.; Leong, G. F.; Still, E. T. (Naval Radiological Defense Lab., San Francisco, Calif.).

Since 1959 experiments have been conducted in this Laboratory to compare the time course of recovery for acute exposures in several species of animals. More recently, experiments were initiated to evaluate the responses of sheep given protracted exposures of ^{60}Co gamma rays. The object of these experiments is to define species differences in recovery potential, to seek the physiological basis for differences in recovery potential, and to provide both generalizations and meaningful estimates for recovery in humans subjected to acute (prompt) or protracted exposures. Dose-rate studies with sheep are reviewed and recent preliminary experiments with swine are described. Hematological changes have been studied in sheep given graded exposures at 2 R/hr. Transient, yet significant, depressions in total leukocyte counts were observed after 175, 100, or 50 R. Injury accumulation, or the converse, recovery, has been measured during low-level exposure by removing the animals from the exposure field when a desired dose has been delivered and immediately subjecting the animals to graded acute exposures to determine the LD_{50}. Using this method, injury accumulation has been evaluated as a function of exposure rate over the range of 0.5 to 4.0 R/hr and of total exposure over the range of 100 to 700 R. Based on preliminary data with swine, the rate of injury accumulation at 4 R/hr appears to be lower than with sheep. In other experiments recovery has been measured following the termination of protracted exposure. This was done by exposing animals at rates which result in the accumulation of radiation injury, removing them from the irradiation field, and determining their acute LD_{50} at various times after the low-level exposure. These results are compared with the time course of recovery after acute exposure. The LD_{50}'s for sheep have been determined at 6 exposure rates over the range of 660 to 2.0 R/hr. Exposure rate-LD_{50} studies have also recently been extended to swine. Although the swine data are incomplete, the results clearly indicate that swine and sheep differ markedly in exposure rate sensitivity. (auth)

49471 (CONF-680410–, pp 5,1-16) OBSERVATIONS OF DOSE-RATE EFFECT OF RADIATION ON BURROS, SWINE, AND CATTLE. Brown, Daniel G.; Cragle, Raymond G. (Agricultural Research Lab., Oak Ridge, Tenn.).

The data from various experiments of external irradiation effects on burros, swine, and cattle which have been conducted at the UT–AEC Agricultural Research Laboratory were reviewed. This review was concerned primarily with those studies in which different dose rates were used. The $LD_{50/30}$ for burros ranged from 375 rads for mixed neutron-gamma radiation (bomb) to 784 R ^{60}Co (0.8 R/min) gamma radiation. In these studies the mode of death (encephalitis) and survival time of decedents were more indicative of dose-rate effect than acute mortality. The studies of daily fractionation of dose indicate that recovery rate of the burro was relatively slow. Preliminary data from a study in progress of the effect of minute intensities of ^{60}Co gamma radiation on swine were reviewed and compared with

other swine data. The $LD_{50/30}$s for 1, 10, and 50 R/min were estimated from the preliminary data to be 650 to 700, 400 to 450, and 350 to 400 R, respectively. Data from daily dose fractionation indicate that swine compensate for irradiation damage more rapidly than other large animal species. The hematology of cattle subjected to dose fractionation was compared. (auth)

49472 (CONF-680410–, pp 6.1-14) EXPOSURE OF SHEEP TO MILLISECOND VERSUS MICROSECOND FISSION RADIATION. Hauver, R. C.; Penikas, Vincent T.; Walker, William J.; Nold, Max M.; Mobley, Thomas S. (Air Force Weapons Lab., Kirtland Air Force Base, N. Mex.).

One hundred forty-three sheep were exposed to bilateral pulsed fission spectrum radiation. The radiation pulse was varied to give dose rates in the range from 3×10^4 rads/min to 2×10^6 rads/min. Eight dose levels ranging from 270 rads to 414 rads were delivered at the higher dose rates, while 10 dose levels ranging from 305 rads to 426 rads were delivered at the lower dose rates. Probit analysis of the mortality data revealed an $LD_{50/60}$, (50%, 60-day lethal dose value), of 404 rads with 95% confidence limits of 390 to 419 rads for the high dose rate group and 402 rads with 95% confidence limits of 391 to 413 rads for the lower dose rate group. There was no significant statistical difference between the $LD_{50/60}$ values or death frequency distribution for the two groups. Hematological and pathological data are presented. (auth)

49473 (CONF-680410–, pp 8.1-6) PERFORMANCE DECREMENT IN PRIMATES IN VARIOUS PULSED IONIZING RADIATION ENVIRONMENTS. Brown, G. Carroll; Barnes, Donald J. (Brooks AFB, Texas).

A series of three experiments designed to investigate differential behavioral and physiological responses to radiation environments were initiated. Fifty-four primates (Macaca mulatta) were trained to a Multiple Avoidance Program (MAP) and divided into 3 groups of 18 animals each. Three dose levels utilizing 6 subjects per level, (5000 rads, 3750 rads, and 2500 rads) were used in each of 3 experiments. The first experiment saw 18 animals receiving the above doses within 40 microseconds at a 6-1 neutron/gamma ratio. The second experiment utilized 18 subjects at a 6-1 neutron/gamma ratio in a radiation environment delivering its dose in approximately 150 milliseconds in order to ascertain dose rate effects at this level. The third and final experiment of this series examined the neutron/gamma ratio effect by utilizing the millisecond dose rate with shielding to effect a 1-6 neutron/gamma delivery. (B.G.D.)

49474 (CONF-680410–, pp 10.1-11) EXPOSURE OF SUBHUMAN PRIMATES TO LOW DOSE-RATE GAMMA IRRADIATION. PART II. HEMATOLOGICAL RESPONSE OF RHESUS MONKEYS DURING AND FOLLOWING EXPOSURE TO GAMMA IRRADIATION. Holland, L. M.; Spalding, J. F. (Los Alamos Scientific Lab., N. Mex.).

Sixteen rhesus monkeys undergoing performance tasks were divided into four groups of four monkeys each and exposed to gamma rays at dose rates of 0, 2.13, 3.19, or 4.26 rads/hour until they had accumulated total doses of 0, 500, 750, and 1000 rads. The animals were bled at 3- to 5-day intervals during a 30-day performance test (which included 10 days of radiation stress), at weekly intervals during a 60-day recovery phase, and at 3- to 5-day intervals during a second 30-day performance test. Response of cellular elements was related to dose and/or dose rate (i.e., the effects were more profound in the higher dose groups, but the timing of the detectable effect and recovery was the same in all groups). (auth)

49475 (CONF-680410–, pp 11.1-14) EFFECTS OF FRACTIONATED WHOLE-BODY X-RAY EXPOSURES ON REPRODUCTIVE ABILITY AND MEDIAN SURVIVAL OF FEMALE DOGS (BEAGLES). Andersen, A. C.; Rosenblatt, Leon S. (Univ. of California, Davis).

Weekly fractionated exposures (50 R) totalling 750 R to female pups caused permanent sterilization. In contrast, reproduction was not seriously impaired by a single median lethal dose given either to young pups or prior to puberty. In another study involving single and fractionated exposures totalling either 100 R or 300 R given at puberty, the subsequent ability of the Beagles to reproduce up to 4 years of age was examined. Reproduction was not impaired in this colony, but nursing pups from irradiated dams gained less in body weight to weaning age than those from non-irradiated dams. The decrease in body weight was less in pups from dams which received a fractionated exposure as compared to those receiving the same amount in a single exposure. The median survival age decreased in proportion to the amount of radiation given. The shortening of life-span was decreased with increasing intervals between first and last exposures totalling 300 R. No such effect on life-span was demonstrable in Beagles receiving a total of 100 R under various exposure regimens. (auth)

49476 (CONF-680410–, pp 12.1-23) EFFECT OF DOSE-PROTRACTION ON RADIATION LETHALITY OF LARGE ANIMALS. Page, Norbert P. (AEC, Washington, D. C.).

The effectiveness of radiation in producing lethality is reduced by dose-protraction, i.e., when the intensity (dose-rate) is reduced or when the total dose is fractionated or given in several smaller doses rather than by a single, brief (acute) exposure. This reduced effectiveness of radiation exposure thus results in an increase in the dose which will produce 50% lethality (LD_{50}). Studies involving variations in dose-rate or fractionated exposure of large animals, both those presented at this symposium as well as others previously published, will be summarized. An attempt will be made to correlate the effect of dose-protraction with published estimates of recovery rates of large animals. (auth)

49477 (CONF-680410–, pp 15.1-20) DOSE-RATE EFFECTS IN MAMMALIAN CELLS IN VITRO AND IN VIVO. Hall, Eric J.; Berry, Roger J.; Bedford, Joel S. (Churchill Hospital, Oxford, England).

S3 HeLa cells were irradiated with gamma rays from cobalt-60 or from radium at dose rates of 44.9, 16.9, 2.37, 0.317, and 0.159 rads/min. Survival curves were obtained at each dose rate and compared. Over this range of dose rates, the fraction of cells surviving a given dose of radiation increased progressively as the dose rate was lowered. In another series of experiments, survival curves were obtained for dose rates of 730, 110, and 0.53 rads/min. No significant effect of dose rate was apparent between the two higher dose rates but a markedly reduced effect at the lower dose rate was apparent. The magnitude of this dose-rate effect observed with cells in culture is sufficient to account in full for the dependence of LD_{50} on dose rate observed in small mammals. Using HeLa cells cultured in vitro, the effect of oxygen was studied at two dose rates, namely, 110 rads/min and 0.59 rads/min. The oxygen enhancement ratio (OER) was found to be 2.5 at the higher dose rate compared with 1.5 at the lower dose rate. The dose response relationship varied with dose rate under aerated conditions but was virtually independent of dose rate under conditions of hypoxia. The influence of the dose rate on OER was also studied using the p-388 ascitic leukaemia of the inbred DBA/2JN mouse. Survival curves were obtained using a serial dilution assay technique in vivo. The cells were irradiated under aerated and hypoxic conditions for acute exposures (130 rads/min) and low dose-rate conditions (0.667 rads/min). The OER was found to be 2.5 and 1.9 respectively for the high and low dose rates used. In this case, the hypoxic condition is that pertaining in the ascitic fluid within the peritoneal cavity of the mouse, and the aerated conditions were produced by bubbling the cells with air in vitro. The effect of the dose-rate dependent change in OER on gross response likely to be obtained in the whole-body irradiated animal is discussed. (auth)

49478 (CONF-680410–, pp 18.1-12) TIME FACTOR IN FRACTIONATED IRRADIATION OF MOUSE SKIN. Comas, Frank V. (Oak Ridge Associated Universities, Tenn.).

This investigation was designed to quantitate the relation between total radiation dose, when given in two equal fractions, and the length of time separating the two half-doses. The biological end point was the development of wet desquamation in the skin of mice. Preliminary data indicate that as the time between the two fractions is increased from one to seven days, so does the radiation dose needed to obtain the same biological effect. This increase in dose amounts to about 2% for each additional day between treatments. By 10 days the amount of radiation required to produce a wet desquamation is decreased. These results are interpreted as reflecting primarily repopulation kinetics of epithelial cells. It is almost certain that the skin radiation reactions heal because nonirradiated neighboring epithelial cells migrate to and proliferate in the irradiated area. As the number of epithelial stem cells increases (as a function of time), more radiation is needed to deplete the number of cells to the critical value under which skin integrity cannot be maintained. (auth)

49479 (CONF-680410–, pp 20.1-23) POST-IRRADIATION CYCLIC RADIOSENSITIVITY CHANGES IN TUMORS AND NORMAL TISSUES. Kallman, Robert F.; Bleehen, Norman M. (Stanford Univ., Palo Alto, Calif.).

The radiosensitivity of cell systems in vivo undergoes a succession of changes during the period of hours to days after small to moderate doses of conditioning radiation. This depends in part upon the kinetics of repopulation; it may be predicted theoretically that cell populations which are heterogeneous with respect to their distribution around the growth cycle and which reproductively survive an initial radiation exposure will be induced to progress synchronously through ensuing generation cycles. This prediction rests upon knowledge about the nature of radiation lesions in cells, and the dose and generation state dependence of these lesions. Experimental evidence from three

different in vivo cell systems tends to support this hypothesis. The acute lethal sensitivity of mice undergoes approximately 3-4 cycles after conditioning doses of 150-300 R, the characteristic period of this cycle is approximately 8 hours, and these recuperation kinetics depend upon the numbers, reproductive integrity, and radiosensitivity states of hemopoietic stem cells in the bone marrow (R. F. Kallman, et al., Radiat. Research 26, 362(1966)). The radiosensitivity of mouse skin has been shown to fluctuate cyclically with a period of 12-14 hours after a conditioning dose of 1000 rads (J. Denekamp, J. F. Fowler, and M. M. Ball, Radiat. Research, in press). In the present studies, it is reported that exposure to a conditioning dose of 300 R causes the cells of a solid C3H mouse sarcoma (KHT) to undergo cyclic changes in radiosensitivity with a characteristic period of approximately 14 hours. The cellular radiosensitivity is determined by quantitative cell transplantation assay performed after disaggregation of tumor cells immediately following second irradiation in situ with second doses of 1200-2000 R. Concurrent with this type of radiation-induced radiosensitivity change in mouse tumors, reoxygenation plays a dominant role in modulating radiation curability. Related data will be presented and will be correlated with knowledge of cell cycle parameters in applicable cell systems. (auth)

49480 (CONF-680410–, pp 21.1-25) EFFECTS OF FRACTIONATED IRRADIATION ON THE SKIN OF PIGS AND OTHER ANIMALS AND ON TUMOURS IN RATS. Fowler, John F. (Royal Postgraduate Medical School, London).

Skin reactions of locally irradiated areas (4 × 5 cm) have been investigated in pigs, some of which have been studied for 6 years after irradiation. The effects of single and fractionated doses of fast neutrons from the M.R.C. cyclotron have been compared with the effects of 8-MV x rays. The experimental results will be related to those obtained on the skin of mice and rats, and to human data from radiotherapeutic experience. The time course of skin reactions after fast neutron single or fractionated doses was the same as after single or fractionated x-ray doses; no difference in repopulation rate of the epithelial basal layer was found. No significant difference was found in long-term effects such as subcutaneous fibrosis, provided that the neutron and x-ray effects at 40–80 days had been the same. The intracellular repair of sub-lethal injury which is completed within a few hours is smaller after fast neutron than after x-ray doses. The well-known increase in total dose required to produce a given effect as the number of fractions is increased, is therefore smaller with neutron than with x irradiation. The question of optimizing relative damage to skin or tumors by fractionated neutron irradiation will be discussed in relation to experimental results on rats obtained by Field, Jones and Thomlinson of the Medical Research Council. (auth)

49481 (CONF-680410–, pp 22.1-18) INFLUENCE OF DOSE RATE IN MAMMALIAN RADIATION BIOLOGY: QUALITY EFFECTS. Upton, Arthur C. (Oak Ridge National Lab., Tenn.).

The influence of dose rate on the production of radiobiological effects in mammals is generally greater in the case of low-LET radiation than in the case of high-LET radiation. As a result, depending on the effect in question and the conditions of irradiation, the RBE of high-LET radiation has been observed to increase with protraction or fractionation of exposure. This relationship has been noted for effects at subcellular, cellular, and tissue levels, and for genetic effects as well as early and late somatic effects. In no case, however, has the effectiveness of radiation for the production of a given effect been analyzed over a wide enough range of LET, dose, and dose rate to define precisely the interaction of these radiologic variables. The situation is usually complicated further in mammals by nonuniformity of energy deposition in tissue and by the influence of different interacting radiobiologic effects on the pathogenesis and expression of the particular radiation response in question. In view of the foregoing, our knowledge of the influence of radiation quality on dose rate effects in mammalian radiobiology remains relatively fragmentary at present. (auth)

49482 (CONF-680410–, pp 24.1-22) MECHANISMS OF EFFECT: WHAT IS OUR UNDERSTANDING OF RECOVERY RATES. Grahn, Douglas (Argonne National Lab., Ill.).

In consideration of our general understanding of recovery and injury some studies have indicated that recovery rates are dose-dependent, i.e., they are depressed at higher doses. The actual magnitude of the recovery constant is dependent upon the experimental method of measurement, including exposure pattern, time intervals, and biological end point. There is no consistent estimate or definition of the component "irreparable injury", and it too, is a function of the experimental method. In certain respects, the concept of irreparable injury is misleading in that it asserts that a constant term exists. Each major radiation syndrome—gastrointestinal, leukopoietic, erythropoietic, etc.—has its own characteristic time course of injury and recovery. Thus, no single constant can accurately express recovery rate when time of observation embraces several syndromes. Recovery rates are age dependent, partially genetically controlled, and subject to superimposed stress. Recovery mechanisms presumably act interdependently at all levels of biological organization; molecular, cellular, systemic, and organismic. Recovery rates at molecular and cellular levels may be more affected by LET factors than certain short-term systemic responses, but all tissue systems probably do not have the same sensitivity to LET variation; and Relative Biological Effectiveness (RBE) and Quality Factors (QF) are certainly not simple functions of LET when measured in complex mammalian systems. Recovery rates are intimately involved, consequently the limitations we place on our understanding of these recovery rates must also apply to the acceptability of RBE and QF values. In conclusion, it should be emphasized that there is as yet no single recovery rate estimate or method of determination of irreparable injury that is descriptive of all syndromes, that is also uniformly accurate over time periods of week to months to years and applicable for dose rates ranging from fractions of a rad per day to many rads per minute. (auth)

49483 (CONF-680410–, pp 25.1-4) EXPLORATION OF FUTURE RESEARCH PATHWAYS. Alpen, Edward L. (Naval Radiological Defense Lab., San Francisco, Calif.).

Within the last five years, we have seen the development of experimental studies that have, to a great extent, demolished our classically structured models of regeneration of function following exposure to sub-lethal doses of ionizing radiation. It certainly must be an axiom of our field today that recovery processes will be at least as complex as the techniques which we apply to reveal them. Cyclic alterations of radiosensitivity, appearance of supranormal radiation resistance or over recovery, residual but inconstant damage, and dependence of recovery rates upon exposure pattern are only part of the family of established patterns that must be explained to provide a basis for future mathematical formulations. What are the fruitful approaches that might enlighten our understanding of the problem? The cellular basis of radiosensitivity certainly provides explanations for some of the observed phenomena, such as the cyclic recovery patterns during the early post-irradiation period, but it is less obvious how alterations of radiosensitivity in the two-week to six-month time frame can be related to partial cell synchrony or relative abundance of certain cell stages of differing radiosensitivity. It appears that the most fruitful approaches will involve the use of those species in which certain phenomena are strongly present to explore the cell regulatory mechanisms. For example, the pig might be the most fruitful subject for study of acquired radioresistance and the sheep the subject of choice for a study of slow recovery process. (auth)

49484 (JPRS-39515, pp 1-13) STUDY OF THE PROTECTIVE EFFECT OF ELECTRONARCOSIS IN EXTREME CASES OF RADIATION SICKNESS. Ivanov-Muromskii, K. A.; Zver'kov, L. S.; Kuz'mina, K. I.; Lavrinenko, V. I.; Mel'nikov, V. G. Translated from Nekot. Probl. Biokibern. Primen. Elektron. Biol. Med., 114-33(1966).

Electronarcosis was induced in rabbits five to seven minutes before, or 15 minutes after, exposure to γ radiation doses ranging from 1500 to 200,000 R. The electronarcosis was induced by means of bitemporal electrodes that delivered a pulsed electric current with a maximum amplitude at 500 ohms of 90 milli amps. The clinical picture of radiation sickness was followed and electroencephalograms were recorded. Observations on animals exposed to γ radiation doses of 1000 R indicated that biologic shock caused the death of 30% of the animals. At doses above 1000 R the degree of symptoms was directly dependent on the radiation dose, with general excitation, tachycardia, spasms, and disturbances of coordination of movement followed by slowing of the respiration, drowsiness, and lowering of nervous reflex activity. Animals exposed to the largest doses died during exposure. The death of animals exposed to large doses of γ radiation was attributed to effects on the central nervous system. Electronarcosis delayed the time of death of animals exposed to doses of γ radiation ranging from 2000 to 6000 R. (53 references.) (auth)

49485 (NYO-2740-5, pp 267-98) RADIOBIOLOGY. Rugh, R. (Columbia Univ., New York. Radiological Research Lab.).

The life-time average body weights and tumor incidence of mice x-irradiated in utero to a uniform dose of 100 R were determined. A difference was found to exist between males and females. X irradiation of primipara and multiparous females revealed differences in the incidence of fetal anomalies. Weight changes were also determined for male and female monkeys that were x-irradiated in utero; organ weights, electrocardiograms,

and blood analysis were also obtained. The effects of preimplantation in utero x-irradiation on mice embryos were determined. It was found that survival rates were the same as for embryos irradiated much later, body weights were only very slightly depressed, but the incidence of cataractogenesis was far in excess of that in later embryonic irradiation. It was found that when the fetal brain of the monkey was x-irradiated, ultrastructural changes in the lysosome organelle occurred. It was also determined that owing to the fact that only neuroblasts are sensitive to x rays at doses used for the experiment, the development of the mammalian eye from primitive neuroectoderm to fully differentiated retina can be sequentially plotted. (E.R.B.)

49486 (NYO-3359-4) SPECIALIZED RESPONSES TO IONIZING RADIATION. PARTS I AND II. Fourth Year Progress Report, May 1, 1967–April 30, 1968. Shaber, Gary S. (Jefferson Medical Coll., Philadelphia, Pa.). Feb. 1, 1968. Contract AT(30-1)-3359. 19p. Dep. CFSTI.

Effects of x radiation on fibrinogen deposition in vivo were investigated. Whole-body irradiation of tumor-bearing rats did not significantly alter the whole-body turnover rate of ^{131}I-labeled-fibrinogen over that of non-tumor bearing animals. There was a marked acceleration of the blood fibrinogen turnover in tumor-bearing rats when compared with non-tumor-bearing rats at all dose levels of whole-body irradiation with and without epsilonaminocaproic acid as drinking water. Epsilonaminocaproic acid did not significantly alter the whole-body turnover of fibrinogen in tumor-bearing rats following whole-body irradiation as it did in non-tumor bearing rats. Local irradiation to the tumor at a dose of 1200 R produced ambiguous results; however, there was an indication that a significant prolongation of turnover of ^{131}I-labeled fibrinogen could be achieved by this means. Studies on the effects of ionizing radiation on taste thresholds were continued. The taste threshold for saccharin in eight rats was determined to be 0.0010%. There was a ten-fold decrease in the taste sensitivity for saccharin following 50 RADS of x irradiation delivered to the tongue. The change in taste sensitivity following irradiation lasted for approximately 72 hrs. Preliminary examination revealed that 30 RADS of irradiation to the tongue may be sufficient to cause a change in the taste sensitivity for saccharin in rats. The rate of incorporation of tritium-labeled thymidine into a taste bud cell was much slower than expected. The effects of colchicine on the taste bud cells were not as dramatic as expected and reflected the fact that the mitotic activity of the taste bud cells was not as high as previously supposed. (auth)

49487 (ORO-2903-39) FACTORS INFLUENCING THE IMMEDIATE RESPONSE OF RHESUS MONKEYS TO BRIEF X-RAY EXPOSURES. Taylor, Henry L. (Aeromedical Research Lab. (6571st), Holloman AFB, N. Mex.); Smith, James C. (Florida State Univ., Tallahassee. Dept. of Psychology). [nd]. Contract AT(40-1)-2903. 4p. (CONF-680433-1). Dep. CFSTI.

From Eastern Psychological Association Meeting, Washington, D. C.

Conditioned suppression training was initiated using x rays as the discriminative stimulus. Control trials were run with the x-ray machine shielded. X ray trials were terminated with electric shocks and control trials were never shocked. Olfactory tracts of eight monkeys were exposed; in two animals sham operations were performed and the tracts left intact, while the tracts were sectioned in the remaining six. Following surgery, the animals were again tested for x ray discrimination. Monkeys with the olfactory tract sectioned could no longer detect x rays. Sham operated animals showed no loss of x ray sensitivity. It is suggested that x ray detection results from the formation of ozone or oxides of nitrogen in the nasal mucosa. (H.L.W.)

49488 (ORO-2903-43) STUDIES IN THE USE OF IONIZING RADIATION AS STIMULI. Progress Report, June 1, 1967–May 31, 1968. (Florida State Univ., Tallahassee. Dept. of Psychology). May 31, 1968. Contract AT(40-1)-2903. 16p. Dep. CFSTI.

X- and γ rays were used to condition aversions to sucrose, fructose, maltose, glucose, and saccharin in rats. Experiments were conducted to determine the quality and intensity of taste discrimination in rats motivated by x- or γ rays. Experiments with rats given a mixture of glucose and saccharin showed that the critical taste factor in the mixture was the saccharin. Rats treated with DMSO avoided the saccharin as well as the water treated controls. Studies on the effect of the circadian rhythm on saccharin aversion were conducted. A conditioned suppression technique was used to investigate immediate detection of x rays by monkeys. The role of the olfactory system in x ray detection was studied. Effects of ionizing radiation on the insect visual system were studied using the moth of the corn ear worm (Heliothis zea). (H.L.W.)

49489 (RLO-2056-3) LOW-LEVEL CHRONIC IRRADIATION OF SALMON. Progress Report. Donaldson, Lauren R. (Washington Univ., Seattle. Coll. of Fisheries). June 24, 1968. Contract AT(45-1)-2056. 19p. Dep. CFSTI.

Chinook salmon were γ-irradiated and compared with unirradiated controls for survival, growth, vertebral numbers, opercular defects, and sex ratio. There was little difference between irradiated and control groups. Each fall since 1962 salmon from both groups returned from the sea to ponds at the University of Washington. Weights and lengths of fish were determined and results are tabulated. Abnormalities were classified as twins, spinal flexures, eye defects, and others. The tabulated results show that only in the categories of spinal flexures and total mortality could a significant difference between experimental and control lots possibly exist, and even here it did not appear likely. (H.L.W.)

49490 (STI/PUB-134) EFFECTS OF IONIZING RADIATIONS ON THE HAEMATOPOIETIC TISSUE. Panel Proceedings Series. Proceedings of a Panel Held in Vienna, May 17–20, 1966. (International Atomic Energy Agency, Vienna (Austria)). July 1967. 160p. IAEA: $3.50; Austrian Schillings 91,–; £ 1.410; F Fr 17,20; DM 14,–.

Papers and discussions on the facts and concepts of normal hematopoiesis and its regulation (6), the qualitative and quantitative aspects of the effects of conventional radiation sources on hematopoiesis (7), and the comparative reactions of hematopoietic tissue from different animals after irradiation (6) are presented. Separate abstracts of 14 papers were prepared for NSA. The general conclusions reached by the panel are briefly summarized. (B.S.L.)

For abstracts of individual papers see: 49254, and 49574–49586.

49491 (UCSF-10-P-2-40) RADIOBIOLOGY OF CELL RENEWAL SYSTEMS. Patt, Harvey M. (California Univ., San Francisco. Lab. of Radiobiology). Feb. 1968. Contract AT(11-1)-Gen-10. 19p. (CONF-680413-3). Dep. CFSTI.

From Symposium on the Effects of Radiation on Cellular Proliferation and Differentiation, Monaco.

A general review of cell renewal systems of the adult mammal is presented. The following topics are discussed in detail: radiosensitivity and components of cell renewal; radiosensitivity and organizational aspects of cell renewal; cell renewal systems and lethal mechanisms. The cell renewal system consists of progenitor elements (stem cells), and proliferating, maturing, and functional cells in an ordered sequence. The steady state systems of cell renewal systems of the rat intestinal mucosa and of hematopoiesis are described with regard to size, time, flux, and decay parameters. The most obvious effects of radiation are on decay parameters among stem-type and differentiated proliferating cells. It appears that cells that are maturing and no longer proliferating are relatively unaffected by doses of radiation sufficient to kill proliferating cells. Although the continued viability of an irradiated cell renewal system depends upon the behavior of its surviving stem cells, the more immediate practical consequences make it necessary to focus upon the mature functional cell. The magnitude of functional cell depletion is influenced by the following specific attributes of the system: the potential for stem cell turnover and recruitment, the transit time for the proliferation compartment, the number of divisions in the proliferation compartment, and the potential for further amplification of production by change in proliferation rate, number of divisions, and growth fraction. Studies on lethal mechanisms show that all of the cell renewal system variables point to a greater x-radiosensitivity for marrow death than for intestinal death. The effectiveness of neutrons relative to x rays is greater for intestinal death than for marrow death. While the death of an organism is not a mirror image of the death of its stem cells, there is a very close relationship. Studies on bone marrow transplantation show that comparatively few cells can rescue lethally irradiated animals by repopulation of a depleted marrow. (H.L.W.)

49492 EXCRETION OF CREATINE AND BETA-AMINOISOBUTYRIC ACID AS A BIOLOGICAL INDICATOR FOR RADIATION INJURY. Bigwood, Edward J. (Univ. Libre, Brussels). Strahlenschutz Forsch. Prax., 4: 255-7(1964). (In German).

The possible sources are discussed of the increased amounts of taurine found in urine following irradiation, the difficulties of evaluation of the normal taurine and β-aminoisobutyric concentrations in urine as a factor to establish a minimal level of radiosensitivity, the possibility of differences in radiosensitivity between humans and the rat below doses of 50 R as measured by taurine excretion, morphological changes found in normal leukocytes exposed in vitro to 50 to 100 R, methods of measurement of urinary β-aminoisobutyric acid following irradiation of humans, and the problem of how much creatine excretion in urine changes following irradiation of humans. (BBB)

49493 EVALUATION OF RADIATION INJURY OF BONE MARROW WITH ELECTRONIC PARTICLE COUNTING DEVICE.

Lee, Hun; Richards, Victor (Pacific Medical Center, San Francisco). Amer. J. Clin. Pathol., 49: 186-9(Feb. 1968).

To evaluate the extent of marrow injury caused by irradiation at different dose levels, a quantitative method of analysis was used for the cell-size distribution changes in bone marrow. This method is based on the relative ratio between non-nucleated cells and nucleated cells in the femoral bone cavity. Rapid disappearance of the radiation-killed nucleated cells from the marrow cell population disturbs the normal ratio, which can be easily detected with this method. To test this new method for the evaluation of radiation injury of the bone marrow, LAF_1 mice were exposed to 100 to 800 R of whole-body x radiation. The cell-size distribution of the femoral marrow was determined 24 hr after irradiation with a Coulter counter coupled to a distribution plotter. The normal distribution was bi-modal, with 2 peaks representing the nucleated cells and non-nucleated cells, respectively. The ratios of 2 peaks were found indicative of the radiation injury received from doses ranging from 100 to 600 R. The ratio for the 800-R group, a slightly larger than LD_{100} dose, was indistinguishable from that of the 600-R group, however, but early clinical symptoms differentiated the former from the latter. (BBB)

49494 BENEFICIAL EFFECT OF GROUNDNUT OIL AGAINST LETHAL SINGLE DOSE, WHOLE-BODY GAMMA IRRADIATION IN RATS. Korgaonkar, K. S.; Ghanekar, Sunanda P. (Tata Memorial Centre, Bombay). Sci. Cult. (Calcutta), 34: 99-100(Mar. 1968).

Studies were undertaken to investigate the effect of certain edible oils on animals subjected to single whole-body lethal dose of γ radiation. Experiments were carried out on 6-weeks old Wistar rats, fed on normal diet containing 1% shark-liver oil. Various edible oils viz., cotton seed (mill pounded), cocoanut (refined), niger seed oil (mill pounded), til oil (refined), safflower oil (Saffola) and ground-nut oil (mill pounded as well as of refined variety) were used. Radiation doses varied between 800 and 2000 RADS. The animals received subcutaneous injections of selected oils in aseptic conditions 3 to 5 times a week with doses ranging from 0.05 ml to 0.2 ml, the treatment period being two weeks prior to and four weeks after irradiation. Body weights and life span of the animals were noted. Among the different oils studied, marked, protective action against radiation lethality was shown by groundnut oil of both refined and mill pounded varieties, although the dose requirements appeared critical for the mode of treatment used. Recovery after the oil treatment also received support from the hematological examination of these animals. Further studies to determine the conditions for optimum beneficial action and to ascertain whether it is prophylactic or/and curative in nature, are still in progress. (auth)

49495 EFFECTS OF X IRRADIATION ON RESPIRATION IN RAT BRAIN TISSUE SLICES. Lott, J. R.; Hines, J. F. (North Texas State Univ., Denton). Tex. J. Sci., 19: 391-4(Dec. 1967).

Oxygen uptake was measured manometrically in in vitro irradiated brain tissue slices that had received 10- or 20 kR doses of x rays. Respiration in the sham-irradiated tissues was relatively constant over the time course of the experiments. These relatively high doses of irradiation failed to alter the oxygen uptake in any of the tissues during the 1st hour postirradiation. During the 2nd hour postirradiation, however, the inhibitory effects of 20 kR on the cortical respiration were statistically significant, amounting to 30% of the control rate. On the other hand, there was a significant increase in oxygen uptake of the pons-medullary slices during the 2nd hour following 10 kR (13%) and 20 kR (22%). The data, in regard to the crease in O_2 uptake by the cortical slices, were in agreement with the reported increase in the oxygen tension in the motor cortex of intact rabbits following 900 to 1500 R whole-body irradiation. It was concluded that relatively high doses of x irradiation are required to alter oxygen uptake in isolated brain tissue slices; that the oxidative metabolism in the cortex and pons-medullary areas is more radiosensitive than in the thalamus and midbrain; and that irradiation brought about opposite effects on respiration in the cortical slices (inhibition) and the pons-medullary tissues (stimulation). (BBB)

49496 THE PROTECTIVE EFFECT OF IRRADIATION COMBINED WITH SHEATHING METHODS ON EXPERIMENTAL NERVE HETEROGRAFS: SILASTIC, AUTOGENOUS VEINS, AND HETEROGENOUS ARTERIES. Hirasawa, Yasusuke; Marmor, Leonard (Univ. of California, Los Angeles). J. Neurosurg., 27: 401-14(Nov. 1967).

A survey of surgical methods of protecting animal nerve grafts with Silastic, vein, and artery sheaths revealed that irradiated heterografts with vein sheaths, as compared to other methods, allow the more advanced axonal organization that is essential for functional restoration. Important factors in the successful use of irradiated nerve graft sheaths are a simple and accurate procedure with an inert material, avoidance of compression of the nerve, and provision for a sufficient blood supply for regenerating axons. It was evident that an inert substance such as Silastic or autogenous vein could provide a successful sheathing method for irradiated nerve heterografts when these criteria were achieved. These findings were correlated with gross, microscopic, and electrophysiological changes, and their significance discussed. (BBB)

49497 EFFECTS OF RADIATION ON THE HYPOTHALAMUS IN MONKEYS. Ibrahim, M. Z. M. (Ames Research Center, Moffett Field, Calif.); Haymaker, Webb; Miquel, Jaime; Riopelle, Arthur J. Arch. Psychiat. Nervenkr., 210: 1-15(1967).

Delayed pathological changes observed in the brains of monkeys receiving x- and γ radiation to the head in a dose of 2000 R given at 50 R/min are described. The pathological changes observed in the hypothalamus and in the rest of the brain strongly suggest a vascular factor as of overriding pathogenic importance in the inception of lesions. (IAA)

49498 RADIOINDUCED CATARACT AS A PROBLEM IN THE RADIATION PHYSIOLOGY OF DEVELOPMENT. Popov, V. V. Biol. Nauki, No. 4, 7-18(1966). (In Russian).

It was shown that cataracts could not be induced unless ionizing rays actually touched the crystalline lens. If this did not happen, an irradiated animal might die of radiation sickness, but the lens would retain its transparency. Contrariwise, radiation injury to the lens, however severe, did not spread the radiation effects to other parts of the body. Thus the crystalline lens was a convenient model for studying the action of various chemical substances as possible radioprotective agents. A major obstacle to such research was the long latent period of development of radioinduced cataract, that is, from months to years. Some successful experiments on mice, frogs, and rabbits involving procedures which accelerated the development of cataracts by shortening the latent period to a few hours or days were described. (JPRS)

49499 FREE RADICAL PROCESSES IN GAMMA-IRRADIATED ANIMAL TISSUE HOMOGENATES. II. EFFECT OF CERTAIN FACTORS ON THE INTENSITY OF THE CHEMILUMINESCENCE OF IRRADIATED TISSUE HOMOGENATES. Urtile, S.; Chou, Yung-tseng; Kozlev, Yu. P. Nauch. Dokl. Vyssh. Shk., Biol. Nauki, No. 2, 54-57(1967). (In Russian).

The effect of radiation dose, temperature, oxygen, and homogenate concentration on intensity of chemiluminescence, were investigated in γ-irradiated (50 to 200 kR doses) mouse tissue homogenates of the brain, liver, and spleen. Chemiluminescent reactions were determined with an FEU-42 photomultiplier. Data showed that expenditure of antioxidants (phospholipids) depends on irradiation intensity and can be expressed as $dA/dt = KI^2$, where A is the concentration of the antioxidant, t is time, K is a constant and I is the intensity of γ irradiation. The intensity of chemiluminescence increases with increase of irradiation dose. The dependence of chemiluminescence (expenditure of antioxidants) on irradiation dose and temperature can be expressed as $dA/dt = K_1^n\sqrt{D} + K_2D^n$, where K_1 and K_2 are constants, D is the γ irradiation dose and n is the factor dependent on the temperature process. The presence of oxygen at time of irradiation increases the intensity of chemiluminescence as compared with the presence of nitrogen. Chemiluminescence also increases with higher homogenate concentration; with increase of homogenate concentration from 3 to 6%, chemiluminescence increases by 10% for a 10 sec period. Brain tissue homogenates display the highest chemiluminescent intensity and spleen tissue homogenates display the lowest. (ATD)

49500 EFFECTS OF AGING AND RADIATION ON ACTIVITY AND METABOLISM IN THE RAT. Morgan, Wesley Gray Jr. Knoxville, Tenn., Univ. of Tennessee, 1967. 103p.

Thesis.

Some long-term behavioral and physiological effects of X irradiation in albino rats were investigated. The exposed animals received 200 R on day 16 of gestation. They were tested at the ages of 2, 6, 16, and 22 months. The first experiment studied the cage-motility of the rat, the habituation of this activity, and the effects of a change in environmental lighting on this activity in both normal and irradiated animals of different ages. The second experiment investigated the resting metabolism in these same animals. No support was obtained for the hypothesis that irradiation mimicked or hastened aging. It was shown that cage-motility changed with age, and that prenatally irradiated rats were more active in cage-motility than their controls through at least most of their life span, and further that irradiated rats were more reactive to a change in environmental lighting than controls when measured by a change in cage-motility. These differences could not be accounted for on the basis of body-weight differences between the groups. The study supported findings of other investigators that there were changes in resting metabolism with age, but that there were no significant differences between the irradiated and control animals in resting metabolism when appropriate

corrections were made for the weight of the animals. (Disser. Abstr.)

49501 TREATMENT OF THYROTOXICOSIS WITH ^{131}I AND POST-THERAPY HYPOTHYROIDISM. Hagen, Garrett A. (Jefferson Barracks Veterans Administration Hospital, St. Louis). Med. Clin. N. Amer., 52: 417-29(Mar. 1968).

Biological effects of irradiation from ^{131}I are reviewed and applied to a discussion of the optimal dose to be used to treat thyrotoxicosis while preventing late complications. Some patients with thyrotoxicosis are especially resistant to radioiodine, while others are especially radiosensitive and develop hypothyroidism. Reports of the steadily rising incidence of post-therapy hypothyroidism to unacceptably high levels by 10 years necessitate a reassessment of radiation therapy dosage levels. The use of low dose levels in the therapy of thyrotoxicosis has thus far achieved an encouraging reduction in the frequency of the complication of permanent hypothyroidism. After reducing the dose of radioiodine administered by mouth to a level of ~80 μCi of ^{131}I per estimated g of thyroid, the incidence of permanent hypothyroidism falls to 5 or 6% by 2 yr of follow-up observation. This can be achieved without a parallel increase in the number of patients requiring retreatment by treating those patients having mild persistent toxicity with potassium iodide for several months. Thus, supplementation with potassium iodide until the full effect of radioiodine is reached provides better management of the thyrotoxicosis and often avoids a second treatment with radioiodine. There is no evidence that radiation-induced thrombosis and obliteration of small blood vessels is sufficient to impair thyroid function or cause hypothyroidism. A possible cause of post-therapy hypothyroidism is the destruction of thyroid tissue via an autoimmune reaction precipitated by the leakage of thyroglobulin following radiation damage. (BBB)

49502 THE BIOLOGICAL EFFECT OF THE INTRATRACHEAL INJECTION OF ^{210}Po. Moskalev, Yu. I.; Korolev, G. K. (Inst. of Biophysics, Moscow). Radiobiologiya, 7: 886-90(1967). (In Russian).

Neutral polonium chloride was administered intratracheally to 182 female Wistar white rats weighing 160 to 180 g, 2.5 to 3 months old. The solution was injected in a volume of 0.5 ml at 0.5, 1.0, 2.0, 4.0, 8.0 and 16.0 μCi per rat, which corresponded to 0.0029, 0.0059, 0.0118, 0.0236, 0.047 and 0.094 μCi/gram live weight. The LD_{50} for 15, 30, 60, 120 and 240 days was found to be 0.068, 0.031, 0.017, 0.011 and 0.0047 μCi/g. At doses of 0.0118 μCi/g or larger, leukopenia developed in the acute stage of intoxication; five to seven months later it was replaced by leukocytosis. The leukopenia developed mainly through the suppression of lymphopoiesis. The sizes of the acutely effective doses and the reaction of the peripheral blood to injury by ^{210}Po depended little on the path of entry and were practically the same for intratracheal, intraperitoneal and intravenous administration. (JPRS)

49503 THE DYNAMICS OF CHANGES OF THE MORPHOLOGICAL COMPOSITION OF THE PERIPHERAL BLOOD IN RATS FOLLOWING ^{239}Pu INHALATION. Kudasheva, N. P. (Inst. of Biophysics, Moscow). Radiobiologiya, 7: 900-5(1967). (In Russian).

Female Wistar rats weighing 150 to 180 g received 0.0047 to 1.028 μCi of ^{239}Pu by inhalation of plutonium citrate and ammonium plutonium pentacarbonate aerosols. At 1.028 and 0.33 μCi of ^{239}Pu in plutonium citrate, moderate changes were observed in the blood system. With 10.28 μCi, the number of leukocytes declined 44%; with 0.33 μCi moderate leukopenia (75 to 60% of the control) was maintained during the life of the rats (480 days). Mild leukopenia was caused by 0.72 μCi of ^{239}Pu in ammonium plutonium pentacarbonate; the number of leukocytes was reduced to 83 to 87% of the control. After inhalation of the minimum quantities present in the lungs (0.0096 to 0.058 μCi of Pu-citrate and 0.0047 to 0.060 μCi of ammonium plutonium pentacarbonate) leukocytosis with neutrophilesis and lymphocytosis was observed in the rats. (JPRS)

49504 THE EFFECTS OF ROUTINE OCCUPATIONAL RADIATION EXPOSURE IN WORKERS AT THE LAWRENCE RADIATION LABORATORY, BERKELEY. Barr, George Douglas. Berkeley, Calif., Univ. of California, 1967. 100p.

Thesis.

The physiological effects from routine occupational radiation exposure was tested in a group of 105 Lawrence Radiation Laboratory (Berkeley) employees. Routine in-plant medical examination results (emphasizing hematology) were compared over a ten-year period with accumulated radiation doses that were taken from film badge records. The range of individual ten-year accumulated radiation doses was 3 to 87 rems. There were no effects of radiation exposure shown in this investigation. (Disser. Abstr.)

49505 CHANGES IN THE SOLAR PLEXUS GANGLIA AT DIFFERENT TERMS AFTER GENERAL IRRADIATION WITH X-RAY SUBLETHAL DOSES. Dumbrova, N. E. (Inst. of Physiology, Kiev). Fiziol. Zh., Akad. Nauk Ukr. RSR, 14: 514-21(July-Sept. 1968). (In Ukrainian).

An experimental study showed that under the effect of x irradiation nerve elements of the solar plexus ganglia underwent a motley picture of change in microscopic and submicroscopic structures having wave character. After the period of the pronounced changes, compensatory and restorative phenomena resulted. (auth)

49506 RADIATION DEPIGMENTATION OF MOUSE HAIR: A STUDY OF FOLLICULAR MELANOCYTE POPULATIONS. Potten, Christopher S. (Christie Hospital and Holt Radium Inst., Manchester, Eng.). Cell Tissue Kinet., 1: 239-54(July 1968).

The x radiation depigmentation of mouse hair was studied by a technique enabling melanocyte per follicle counts to be made. Distributions for normal skin showed a large peak corresponding to the zigzag hair type. Changes in the frequency distributions of melanocytes per follicle after irradiation are presented for Strong F and DBA-1 mice irradiated in anagen or telogen stages of hair growth. These distributions clearly suggest the existence of some precursor cells, and the dose-response curves obtained by defining radiation survivors as follicles containing more than ten melanocytes gives the sensitivity of these cells to inactivation. D_0 values are 180 to 220 RADS. A melanocyte–melanoblast model is proposed for the follicular melanocyte cycle which can be outlined as follows: The telogen follicle contains a small number of amelanotic melanocytes that survived through catagen. These cells possess the ability to repopulate the follicle with melanocytes. In catagen functional and/or amelanotic melanocytes are lost at random. Genes for dilution (possibly only when modified by other coat color genes) and radiation both increase the change of melanocyte loss at catagen by altering the melanocyte-dermal papilla relationship. One way in which this is affected is by a shortening of the dendrites. A feedback may operate in the follicle so that the full complement of melanocytes is achieved whatever number of melanocytes persists in telogen. (auth)

49507 DISTURBANCES IN THE DEVELOPMENT OF SMALL COLONIES FOLLOWING THE IRRADIATION OF DIFFERENT PARTS OF SINGLE CELLS IN TISSUE CULTURE WITH A HETEROCHROMATIC MICROBEAM OF ULTRAVIOLET LIGHT. Smith, C. L.; Dendy, P. P. (Cambridge Univ., Eng.). Cell Tissue Kinet., 1: 225-37(July 1968).

Various sites in mouse L cells were irradiated using an heterochromatic uv microbeam 3.5 μ in diameter, and the subsequent growth of the cells was studied for 5 to 7 days after irradiation. Modifications in the growth curves were recorded for the total number of cells in each radiation category and significant anomalies in the DNA metabolism of some of the progeny of irradiated cells were noted at the end of the post-irradiation incubation period. The frequency with which binucleate and giant cells were produced was also recorded and the results analyzed. For equivalent absorbed doses, the nucleus was more sensitive than the cytoplasm in experiments of this type and there was some evidence to suggest that the maximum sensitivity was achieved when some nucleolar material was irradiated. (auth)

49508 AGE-DEPENDENT TOXIC PROPERTIES OF ACTINOMYCIN D AND X-RAYS IN CULTURED CHINESE HAMSTER CELLS. Elkind, M. M.; Sakamoto, K.; Kamper, C. (National Cancer Inst., Bethesda, Md.). Cell Tissue Kinet., 1: 209-24 (July 1968).

A comparative study was made of the toxic properties of actinomycin D and x rays using synchronized populations of Chinese hamster cells cultured in vitro. X-irradiated cells were most resistant in the latter half of the DNA synthetic period (late S). While cells treated with actinomycin D appeared to go through a survival maximum at the same age, they were most resistant after the completion of DNA synthesis; i.e., in G_2 (or G_2-mitosis). In spite of these differences, actinomycin D damage in late S cells interacted with x ray damage. Thus, a common locus for the site of actions of both agents is suggested which may be in or around the genome of a cell in view of the well-known DNA binding properties of actinomycin D. (auth)

49509 CHANGES IN THE JUXTAMURAL DIGESTION IN VARIOUS SEGMENTS OF THE SMALL INTESTINE OF RATS AFTER TOTAL X-RAY IRRADIATION. Bulbuk, G. A. (Central Research Roentgen-Radiological Inst., Leningrad). Byull. Eksp. Biol. Med., 66: 42-4(July 1968). (In Russian).

Digestion in the upper and the lower segments of the small intestine of rats was studied at different periods of time following exposure to total-body x irradiation at doses of 550 and 1200 R. More marked disorders of digestion were seen 3 days after irradiation, especially after a dose of 1200 R. The degree of disorders in different segments of the small intestine was unequal, the

lower segments were more resistant to x rays than the upper. (auth)

49510 EFFECTS OF SINGLE DOSE X IRRADIATION ON THE PIGMENT CELLS OF THE PET MOUSE GASTROCNEMIUS. Reams, Willie M. Jr.; Schaeffer, Barry E. (Medical Coll. of Virginia, Richmond). J. Invest. Dermatol., 51: 33-6(July 1968).

The irradiation of intramuscular pigment cells of mice with x rays resulted in a progressive decrease in the number of melanocytes with increasing dosage of radiation. Apparently the pigment cells were damaged or destroyed by the x rays. The conclusion is tendered that pigment cells fundamentally are radiosensitive and that the integument normally serves as a radioprotective agent. The epidermis and/or dermis, then, would be the mediators of hyperpigmentation responses of the pigment cells to radiation. (auth)

49511 INFLUENCE OF IONIZING RADIATION ON THE MECHANISM OF THE DEVELOPMENT OF FEBRILE REACTION. Kalinina, N. A. (Inst. of Experimental Medicine, Leningrad). Radiobiologiya, 8: 52-7(1968). (In Russian).

Rabbits were irradiated with 1000 R at 17.6 R/minute and five days later were administered 0.3 ml of turpentine in the hip region. Before the experiment and every two hrs for 24 hrs after administration of the turpentine the leukocytes in the peripheral blood were counted and the temperature was measured rectally. Aseptic peritoneal exudate obtained 16 hrs after intraperitoneal injection of apyrogenic physiological solution in donor rabbits was used as an endogenic pyrogen. In the irradiated rabbits, acute radiation sickness developed in a severe form, they lost weight, and sharply expressed leukopenia developed. Febrile reaction was much more weakly expressed than in unirradiated rabbits, not through suppression of ability to react to endogenic pyrogens but because of reduced formation of those pyrogens, evidently because of a sharp reduction in the number of leukocytes and a slower and weaker development of the inflammatory process. (JPRS)

49512 INVESTIGATION OF RADIOTOXINS OF A QUINOID NATURE. Laprun, I. B.; Eidus, L. Kh. (Inst. of Biophysics, Moscow). Radiobiologiya, 7: 831-4(1967). (In Russian).

Two methods previously proposed for the detection of toxins of a quinoid nature, spectrophotometric and polarographic, were tested on extracts from the bone marrow and liver of irradiated and control rats. The former method revealed no changes. The polarographic method revealed an increase of quinoids in the liver of irradiated animals in quantities agreeing with those reported in the literature but varying greatly in individual experiments. Quinones were not detected polarographically in the bone marrow of rats irradiated with a dose of 1 kR. (JPRS)

49513 CHANGE OF THE MITOTIC ACTIVITY OF EPITHELIAL CELLS OF THE CORNEA IN ANIMALS EXPOSED TO SMALL DOSES OF γ RADIATION. Keizer, S. A.; Ivanov, K. V.; Zavalishina, O. A. Radiobiologiya, 7: 857-9(1967). (In Russian).

In male white rats that received 0.05 and 0.5 R/day of γ radiation for 8 mo, the mitotic activity of corneal epithelial cells was suppressed and pathological forms of the mitoses increased, more distinctly at 0.5 R/day. In guinea pigs receiving 0.05 and 0.5 R/day for two years, pathological forms of mitoses increased considerably, but reduction of the mitotic activity occurred only at 0.5 R/day. In rabbits receiving 0.05 R/day for 2 yr there was a slight increase in the mitotic activity of the corneal epithelial cells and a definite increase in the pathological forms of the mitosis. (JPRS)

49514 BIOLOGY OF RADIONUCLIDES. Catsch, Alexander (Technische Hochschule, Karlsruhe, Ger.). pp 372-438 of Handbuch der Medizinischen Radiologie. Vol. 2. Part. 2. Berlin, Springer Verlag, 1966. (In German).

The author discusses methodological considerations, properties of incorporated radionuclides, resorption of radionuclides, distribution patterns, kinetics of distribution, biological discrimination between chemically related radionuclides, inhalation of radionuclides, and properties of radioactive particles. Special problems related to effects of biological factors on properties of radionuclides, radionuclide distribution patterns during gestation and lactation, affinity of radionuclides for tumor tissue are discussed. Experimental methods for altering biological properties of radionuclides by complexing agents, isotopic dilution, colloidal carriers, hormones, vitamins, and diets are compiled. Dosimetry of incorporated radionuclides, acute and delayed injuries, quantitative problems of radiotoxicity and dose, effects of chronological dose fractionation, and linear energy transfer are discussed. Radionuclide poisoning in humans, chemical toxicity, and problems of transmutation are considered. Experimental bases for therapy of radionuclide poisoning are compiled and discussed. (BBB)

49515 THROMBOELASTOGRAPHIC CHANGES IN THE COURSE OF THERAPY WITH THE 42-MeV BETATRON FOR NEOPLASIA OF THE FEMALE GENITAL REGION. Schiatti, E.; Cipolli, P. L.; Coucourde, F. (Univ., Pavia, Italy). Haematologica (Pavia), 52: 401-9(1967).

Changes in blood coagulation were studied by the thromboelastogram in the course of treatment of 14 patients with gynecologic cancers. The patients received 42-MeV x ray therapy in the hypogastric region through 2 opposing portals (15 × 15 to 17 × 17 cm) with maximum daily doses of 200 R and weekly doses of 1000 R. The thromboelastogram was recorded before therapy and after total doses of 2400, 4800, and 6800 R had been reached in each patient. The pretreatment thromboelastogram showed a tendency toward hypercoagulability. Irradiation tended to produce a state of hypocoagulability. The radioinduced changes in blood coagulation are attributed to effects on plasma factors and platelets which influence the formation of thromboplastin. (BBB)

49516 EFFECT OF IONIZING RADIATION AT THE CELLULAR LEVEL. Mukerji, B.; Bhattacharya, K. L. (Chittaranjan National Cancer Research Centre, Calcutta). Sci. Cult. (Calcutta), 34: 97-9(Mar. 1968).

Doses of ^{32}P administered internally to rats resulted in decreased counts of leukocytes. The fall in leukocyte count was directly correlated with the radiation dose rate. The effects of colloidal ^{198}Au on leukocytes were similar to those of ^{32}P. The immediate effects of radiation on the cell are summarized as follows: delay in onset of mitosis; complete inhibition of mitosis; chromosome aberrations and breakage; abnormal functioning of the cell; and death of cells following one or more divisions after irradiation. (H.L.W.)

49517 STUDIES ON THE CELLULAR BASIS OF RADIATION LETHALITY. I. THE PATTERN OF MORTALITY IN THE WHOLE-BODY IRRADIATED PLANARIAN (TRICLADIDA, PALUDICOLA). Lange, C. S. (Christie Hospital and Holt Radium Inst., Manchester, Eng.). Int. J. Radiat. Biol., 13: 511-30(1968).

The planarian lends itself to parallel cellular and whole animal studies because it contains a single, morphologically identifiable population of toti-potential stem cells, without which the animal cannot long survive. Two genera, including five species and three auto- or allopolyploid biotypes, of planarian were chosen for a study of the cellular basis of radiation lethality. The distribution of mortality times was found to be uni-modal and the x-ray dose-response curve, sigmoid. By the use of antibiotics, infection by commensal organisms was shown not to be a significant factor in mortality. The effects of several other treatments are interpreted in terms of altered metabolic rate. It is suggested that planarian radiation mortality is the end-result of a loss of reproductively intact stem cells leading to insufficient replacement of worn parts of vital tissues. (auth)

49518 DETERMINATION OF A ^{60}Co $LD_{50(30)}$ FOR THE WILD-CAUGHT COTTON RAT (SIGMODON HISPIDUS). Kellogg, Forest E.; Provost, Ernest E.; Pelton, Michael R. (Univ. of Georgia, Athens). Radiat. Res., 35: 458-64(1968).

The mortality response of wild-caught cotton rats exposed to cobalt-60 gamma radiation was studied. One hundred and forty-four animals were subjected to calculated air exposures ranging from 300 to 1500 R. Data on survival time at various treatment levels were tabulated, and a combined group $LD_{50(30)}$ of 1155 R was computed by probit analysis. This response of the cotton rat was compared to the response of other small mammals as reported in the literature. The mechanisms responsible for the apparent radioresistance in this species were not investigated. (auth)

49519 PREMITOTIC RADIOSENSITIVITY OF MAMMALIAN CELLS. Walters, Ronald Arlen. Fort Collins, Colo., Colorado State Univ., 1967. 137p.

Thesis.

Life-cycle analysis techniques were employed in investigating radioinduced division delay in mammalian cells. The effect of X irradiation on macromolecular synthesis as it affected the progress of the cell about the life cycle was studied and the effect with respect to the position of the cell in the life cycle at the time of irradiation was evaluated. The temporal mark defining the final point of inhibition prior to division was located very precisely in late G_2 and found to be dose-independent and characteristic for each of three cell lines. This mark was interpreted as the time preceding division at which some moiety necessary for for cell division was completely synthesized, such synthesis being sensitive to earlier X irradiation. No difference in the length of division delay was noted for Chinese hamster ovary cells irradiated at different portions of the life cycle. Cells synchronized either by treatment with excess thymidine or by mechanical

selection of mitotic cells exhibited similar division delays regardless of the position of the cell in the life cycle at the time of irradiation. The effect of X irradiation on macromolecular synthesis was investigated. It was established that recovery of the capacity to divide after irradiation did not occur in the absence of protein synthesis. The stability of messenger RNAs coding for essential division proteins was measured as a function of the induced division delay period; the mean life time of mRNA was one hour. In addition, RNA synthesis was required during the division delay period. The results presented were most consistent with a concept of uniform radiosensitivity throughout the life cycle as measured by division delay. Ionizing radiation reversibly interrupted the capacity of any cell to traverse the life cycle; thus the effect could be upon some process basic to all cells. It was suggested that the initial radiation effect involved some process(es) in the translation of a coded message into functional protein with relatively little effect on the transcription of a messenger RNA from DNA. (Disser. Abstr.)

49520 THE ANATOMIC SITE OF VASCULAR INJURY IN MOUSE SKIN EXPOSED TO ULTRAVIOLET LIGHT. Rea, Thomas H. (New York Univ., N. Y.). J. Invest. Dermatol., 51: 100-7(Aug. 1968).

A study of cutaneous vascular damage following uv light exposure of hairless mice is reported. The technique of carbon labeling of injured vessels was the method employed. Ultraviolet light from a cold-quartz source was found to produce a typical biphasic response consisting of an immediate phase characterized by injury to venules and a late phase characterized by injury to capillaries and venules. Ultraviolet light from a fluorescent sun lamp did not elicit an immediate response but only a delayed-prolonged phase. Failure of enough photons to penetrate to the dermal vessels is offered as an explanation for the absence of the immediate response. Ultraviolet light from a hot-quartz lamp produced a biphase response. The onset of the delayed-prolonged phase of injury was sooner when the hot-quartz lamp was used as compared with uv light from the fluorescent sun-lamp. (auth)

49521 HYPERTENSION AND NEPHROSCLEROSIS FOLLOWING SUBLETHAL PARTIAL AND WHOLE-BODY X-IRRADIATION. Wachholz, Bruce William. Rochester, N. Y., Univ. of Rochester, 1967. 242p.

Thesis.

The relationship between hypertension and nephrosclerosis in the radioinduced hypertensive syndrome was studied in male rats either at periodic scheduled sacrifice times or periodically throughout their lifespan after single sublethal doses of X irradiation by various modes, i.e., the whole body (300 R or 500 R), the whole body with the kidneys shielded (300 R or 500 R), or the kidneys only (300 R, 500 R, or 1000 R). These studies included blood pressure measurements, renal pathology and microangioradiography, blood urea nitrogen and plasma chloride measurements, hematology, urinalysis, body weight and certain organ weights. Increased blood pressure was noted at all dose levels and with all modes of irradiation, and was directly dose-dependent, but independent of mode at given dose levels. In general, arteriolonephrosclerosis was seen earlier in irradiated kidneys than in kidneys shielded during whole-body irradiation, and these shielded kidneys showed the lesion earlier than did the kidneys of non-irradiated rats. Usually the detection of increased blood pressure preceded that of arteriolonephrosclerosis. There was a rough correlation between the degree of nephrosclerosis and the increase in blood pressure. These results were discussed in terms of possible mechanisms of hypertension and compatibility with the concept of premature aging after irradiation. Comparisons were made of the 20-week survival of rats given various modes and doses of irradiation. (Disser. Abstr.)

49522 PLATELETS AND ATHEROGENESIS. PART 2. AMELIORATION OF CHOLESTEROL ATHEROGENESIS IN RABBITS WITH REDUCED PLATELET COUNTS AS THE RESULT OF ^{32}P ADMINISTRATION. Cohen, P. (Rijksuniversiteit, Utrecht); McCombs, H. L. J. Atheroscler. Res., 8: 389-98(May-June 1968).

Two schedules of radiophosphorus administration were used to induce thrombocytopenia in rabbits to study the possible role of platelets in the encrustation phase of cholesterol atheromatosis. Fifteen rabbits received 1.25 mCi of ^{32}P (sodium phosphate) intravenously and had complete blood counts 7, 14, and 21 days later (covering the period of bone marrow suppression and recovery); then a second 1.25-mCi dose of ^{32}P was given. This was followed by 0.75 mC doses at 14-day intervals for a period of 140 days, during which weekly complete blood counts and serum cholesterol determinations were done. During the last 60 days of this program a daily feeding of 1.25 g of cholesterol was given to each rabbit. In this group, that was less vigorously treated with ^{32}P, no deaths occurred from infection, but a chronic 50% drop of the platelet count was noted. The latter apparently had no effect on the degree or distribution of cholesterol deposits on the aorta. However, the platelet count of 300,000/mm^3 was not a thrombocytopenic level and may, in fact, have been at the lower end of a permissive range for cholesterol deposition. With a heavier dose schedule of ^{32}P, platelets were reduced to one-fourth of normal, and this appeared to have an ameliorating effect on the development of aortic atheromatosis. A heavy mortality from infection, undoubtedly the result of an excessive reduction of granulocytes, could have biased the statistical analysis in favor of the observed results. Nevertheless, the findings are complementary to previous work that showed that cholesterol atheromatosis in the rabbit may be enhanced in a setting of chronic thrombocytosis. (BBB)

49523 SENSITIZATION OF THE HYPOXIC GASTRO-INTESTINAL TRACT, IN VIVO, TO RADIATION DAMAGE BY INDANETRIONE HYDRATE. Hornsey, Shirley; Hedges, M. J.; Bryant, P. E. (Hammersmith Hospital, London). Int. J. Radiat. Biol., 13: 581-3(1968).

Mice were irradiated with electrons while breathing oxygen and while breathing nitrogen. Indanetrione was injected at various intervals before and after irradiation. Death occurring between three and four days after irradiation was attributed to damage to the small intestine. Results indicated that indanetrione sensitized hypoxic intestinal tissue, but not well oxygenated tissue. (H.L.W.)

49524 CHANGES IN THE RATE OF OXYGEN CONSUMPTION BY MOUSE SPLEEN FOLLOWING WHOLE-BODY X-IRRADIATION. Evans, N. T. S. (Hammersmith Hospital, London). Radiat. Res., 35: 465-71(1968).

Mice exposed to 500 R of X radiation were sacrificed at intervals up to nine days after irradiation and the oxygen consumption of the chopped spleens was measured polarographically in Eagle's basal medium. Oxygen consumption dropped by about 30% over the six hours following irradiation and rose again after 24 hours to about 10% below the control value. A second minimum was found at three to four days. The wet-to-dry weight ratio of the spleen tissue showed no significant change. The drop in oxygen consumption over the first six hours was probably due to cellular damage, and the subsequent rise to removal of the damaged cells. (auth)

49525 CHANGES OF THE SKIN AFTER RADIUM THERAPY OF CANCER OF THE LARYNX AND RECONSTRUCTIVE OPERATIONS. Savchenko, E. D.; Molchanova, K. A. (Moscow Scientific-Research Inst.). Med. Radiol., 13: No. 8, 20-6(Aug. 1968). (In Russian).

Pathomorphological investigations of the skin of the neck repeated courses of irradiation for cancer of the larynx showed that in the skin there prevailed dystrophic changes; reparative processes were marked weak. Experience demonstrated that, notwithstanding marked pathomorphological changes in the skin, it is possible to perform reconstructive operations of closing gaping defects of the pharyngeal wall and cervical region of the esophagus. The most favorable times for such operations are 3 to 6 months after the last course of irradiation. One should exercise great care to the tissues. In the presence of even weakly pronounced reparative processes for plastic purposes it is expedient to tissues of the neck surrounding the defect. In cases of complete inhibition of these processes plastic repair with Filatov's pedicle graft should be done. Great importance should be attached to activation of reparative processes in the skin of the neck after repeated courses of irradiation. Shostakovich ointment applied to the skin of the neck was used for this purpose. (auth)

49526 ANATOMICAL STUDY OF HYPOPHYSIAL NECROSIS AFTER IMPLANTATION WITH ^{90}Y. Chomette, G.; Vedrenne, C.; Bonis, A.; Auriol, M.; Pinaudeau, Y.; Bocherious, C. (Hopital Paul-Brousse, Paris). Neuro-Chir., 12: 689-701(1966). (In French).

A histologic study was made of pituitary radionecrosis caused by ^{90}Y in 20 patients dying from 2 days to 3½ yr after radioisotope implantation. Stages of development of this radioinjury were followed. During the first 5 days necrobiosis was evident with severe edema, which could be lessened by surgical intervention. In an average of 3 weeks the area of necrosis became clearly defined and corresponded approximately to the peripheral limits of irradiation from the ^{90}Y. In the following months, around the necrotic area progressive cytolysis was noted, accompanied by impairment of the capillary network, thus leading to the residual effects of irradiation. The progressive development of radionecrosis was in contrast to the sudden onset of pituitary insufficiency that appeared in the first days after implantation. It was pointed out that early wild changes are a prelude to severe residual effects in brain tissue. (BBB)

49527 FIBROSARCOMA OF THE TONGUE AFTER X-IRRADIATION THERAPY FOR SQUAMOUS CELL CARCINOMA OF THE

TONGUE: REPORT OF CASE. Castigliano, S. Gordon (American Oncologic Hospital, Philadelphia). J. Oral Surg., 26: 197-200(Mar. 1968).

Only 3 instances of unquestioned neoplastic malignant disease developing in therapeutically irradiated tissue were encountered in approximately 15,000 patients who received a total of about 230,000 x ray treatments over 30 yr. Fibrosarcoma of the tongue developing after x irradiation with 7400 R for a previously existing classic epidermoid squamous cell carcinoma is reported. (BBB) (TSS)

49528 CARCINOMA OF THE CERVIX. Burrows, Brian D.; Lynch, Gerard A. (Northern Ireland Radiotherapy Centre, Purdysburn, Belfast). Ulster Med. J., 37: 71-8(Winter 1968).

Complications encountered in the treatment of 520 patients with cervical cancer by Ra and/or external x rays are reported. The treatment was usually given in two applications of Ra and, when not supplemented by external radiation, the dose was 7500 R. In patients over 65 yr of age the dose was reduced to 6500 R. If the patient received supplementary external x ray treatment the dose was reduced to 6500 R. The 300-kV x ray therapy was given in 15 treatments over 3 weeks, to doses between 1500 and 2000 R depending on the size of the patient. Mild rectal reactions occur in a moderate proportion of patients treated radically by radiotherapy, but these reactions normally resolved within a few weeks of completion of treatment. Severe complications occurred in a small percentage of cases, particularly rectal ulceration. This resulted from slipped applicators or high paracervical dose, and proceeded to fistula formation necessitating permanent colostomy in some cases. The percentage of patients developing such complications varied greatly in published reports, from 1.5 to 5.5%. In 410 cases treated radically by radiotherapy, 15 (3.6%) suffered persistent bladder or bowel symptoms, but only in 6 (1.4%) did fistulae develop. Severe damage to the bladder is rare but fibrosis at the lower end of a ureter, following radiation therapy, may develop. (BBB)

49529 LESIONS OF HEARING CAUSED BY RADIOACTIVE RADIATIONS. Manojlovic, Ciro; Mitrovic, Momcilo (Military Academy of Medicine, Belgrade). Ann. Oto-Laryngol., 84: 543-6(July-Aug. 1967). (In French).

Three cases of radiation injury to the ear are presented, and references to this type of injury in the literature are discussed, particularly as to its rarity. The 3 patients were irradiated accidentally while working with the Nulta Reactor at the Scientific Institute in Vinca, Yugoslavia, in 1958. Irradiation by neutrons and γ rays resulted in a whole body dose of 450 to 1000 rem. Immediately after irradiation, patients showed typical symptoms of radiation sickness: headache, vomiting, diarrhea, and general weakness. After 8 months, otorhinolaryngological, audiometric, EEG (electroencephalographic), and vestibular examinations were made. All the EEG voltage readings were extremely low, which seemed to indicate a direct though very weak effect of irradiation on bioelectric activity. Later evaluations of the patients were made in 1963. In all 3 cases hearing showed an improvement after the general symptoms disappeared. The final diagnosis was retrolabyrinthine perceptive deafness caused by irradiation. It was concluded that little is known about this type of radiation injury. (BBB)

49530 DERMATOLOGY PROBLEMS OF ABILITY TO WORK WITH THE RISKS OF IONIZING RADIATION. Righi, E.; Strambi, E. (CNEN, Rome). Securitas, 52: 101-10(1967). (In Italian). (RT/PROT-(68)3).

Workers at a nuclear research center were regularly examined during a five years period; 1,396 pre-employment medical examinations and some 6,000 following controls were carried out. Skin diseases caused a restriction in work involving a contamination hazard in six pre-employment and in 10 following examinations. On the basis of the recent scientific knowledge, the problems related to the dermatological evaluation of qualifications for radiation work are discussed. (auth)

49531 RADIOACTIVE TREATMENT OF POLYCYTHEMIA VERA. Norcross, John W. (Lahey Clinic Foundation, Boston). Lahey Clin. Found. Bull., 17: 57-61(Jan.-Mar. 1968).

Effects of ^{32}P in patients with polycythemia vera and its side-effects, including leukemia, are discussed. Although the effects of radiation on the blood platelets is obvious after 3 weeks, the full effect on the erythrocytes is not complete for 3 months. There is diminishing irradiation of the whole-body during the first week, at the end of which time all remaining ^{32}P is fixed within the bone marrow. In 3 or 4 days 50% of it is excreted. Hematologic remissions are satisfactory in from 85 to 90% of patients so treated, and no patient is completely resistant to this therapy. Deaths from vascular accidents have decreased since the use of ^{32}P and the average survival time has increased. The incidence of acute leukemia as a complication of ^{32}P therapy for polycythemia vera has been reported by 3 authors as 11.6, 15, and 20%. Although the time interval between the initiation of ^{32}P therapy and the onset of leukemia bears no direct relation, the total dose administered appears to be important. These factors conclusively show that the development of acute leukemia is the direct consequence of radiation treatment, either with x rays or ^{32}P. In the Lahey Clinic radiophosphorus was administered 206 times to 89 patients, in an initial dose of 5 mCi orally, and subsequent doses ranging from 2 to 10 mCi. It was never repeated before a minimum of 3 months had elapsed to ascertain the full effect of the administered dose. There were 12 deaths; 4 (33%) died from acute leukemia, and 5 others (41.6%) died from myeloid metaplasia. The dose of ^{32}P given to the patients who died from leukemia varied between 45 and 116 mCi. The leukemia developed from 8 to 10 yr after the initial dose of ^{32}P was given. It is concluded that ^{32}P should be used only in cases that are resistant to chemotherapy, when the platelets consistently number more than 1,000,000, or when the patient is over 60 yr of age. (BBB)

49532 STATISTICAL CONTRIBUTION TO THE PROBLEM OF POSSIBLE LEUKEMOGENESIS AFTER ROENTGENTHERAPY FOR THYMIC HYPERPLASIA. Schiavetti, E.; Capelli, L. (Ospedale dei Bambini, Milan). Med. Nucl.-Radiobiol. Lat., 10: 405-37(1967). (In Italian).

After an extensive review of literature an epidemiological study was carried out on a random group of 1835 children x irradiated for thymic hyperplasia between the years 1939 and 1960 at the Milan Children's Hospital. Thirty four of the 1,312 children documented died, nine with malignant cancer. Six cases of leukemia occurred after an average period of about 5 years, at the age of greater incidence of spontaneous leukemia, and it was distinctly prevalent in males. Of the control group of 997 brothers mortality was found to be slightly greater than in irradiated subjects but no cases of malignant cancer appeared. The control period varied from 4 to 24 years and on a total of 8,678 persons-years exposed to risk the average observation period was 6.62 years. No relation was shown between radiation doses and incidence of leukemia. In data gathered from literature and case histories, 17 cases of leukemia were identified in a total of about 7,400 children irradiated for thymic hyperplasia. A statistically significant increase of leukemia in irradiated subjects was found in comparison to that in the general population; this was not confirmed when the brothers were used as control group. An ideal control group of children suffering from thymic hyperplasia and not traced with irradiation or drugs, is so far lacking in literature. Only thus could the possible role of thymic hyperplasia in the onset of leukemia be verified. (82 references) (auth)

49533 GROSS MORPHOLOGICAL CONSEQUENCES OF IRRADIATION OF THE CEREBELLUM IN INFANT RATS WITH REPEATED DOSES OF LOW-LEVEL X RAY. Altman, Joseph; Anderson, William J.; Wright, Kenneth A. (Massachusetts Inst. of Tech., Cambridge). Exp. Neurol., 21: 69-91(May 1968).

The cerebellum of rats was irradiated 1 to 10 times with daily doses of 50 to 200 R of hard x rays on successive days following birth to investigate a method for selectively eliminating a specifiable proportion of the postnatally proliferating and migrating precursor cells of cerebellar microneurons. Gross morphologic consequences of different irradiation schedules were determined. Mortality rate was not raised by localized cerebellar irradiation, except in rats that received 10 successive daily doses, and the animals that survived through infancy, including those that received 10×200 R, showed normal body growth. Total brain weight was markedly reduced after more than 2×100 to 200 R; the highest reduction was seen after 10×200 R. The bulk of reduction in total brain weight could be attributed to weight loss in the intended area of irradiation. Areal measurements showed that cerebellar irradiation did not appreciably affect the growth with age in the width and length of cerebrum, but increase in the length and height of the cerebellum was markedly retarded. With single or multiple doses of 200 R cerebellar length was greatly reduced by day 10. Reduction at 30 and 90 days was not evident with 1 to 2×200 R, but with 4 to 5×200 R cerebellar length was reduced to the level of control animals 10 days of age, and with 10×200 R to the level of neonates. (BBB)

49534 VACCINIA IN WHITE RATS AFTER TOTAL GAMMA IRRADIATION. Svet-Moldavskaya, I. A. (Research Inst. of Viral Preparations, Moscow). Acta Virol. (Prague), 12: 271-4 (May 1968).

Rats were irradiated with a whole-body dose of 400 R from ^{60}Co and 24 hr later inoculated intravenously with the Tashkent strain of vaccinia virus. In preliminary experiments the survival of rats after irradiation with 400 R was examined. Of 50 rats irradiated in 2 experiments, 2 rats died in each experiment 15 days or later after irradiation. Macroscopically, hypoplasia of spleen, lymph

nodes, and thymus, typical of radiation disease, was found. In experiments with the virus, as a rule, after 5 to 6 days of incubation the rats developed progressive adynamia, rhinitis, and conjunctivitis, terminating fatally in a further 2 to 4 days. In 10 experiments, all the rats died; in the remaining 2 the death rate was 90 and 93% respectively. None of the nonirradiated 144 animals inoculated showed clinical signs of the disease or died. Course of the disease in irradiated and nonirradiated animals revealed the following differences. Irradiated animals developed intensive viremia with dissemination of virus into various organs. The virus multiplied only in the lung and brain tissues. In nonirradiated rats the virus also penetrated into the blood and different organs, in particular the lungs and brains. However, the virus did not multiply and gradually disappeared within 6 to 7 days. In the irradiated rats, the disease occurred only after large doses of intravenously inoculated virus (not less than 10^6 pock-forming units (PFU)/ml). Subcutaneous and intranasal inoculation of irradiated animals was ineffective. The influence of preliminary immunization of susceptibility of irradiated rats to vaccinia virus was also studied. Immune rats irradiated 24 hr before challenge were completely protected from a lethal dose of virus for 18 months. Preliminary experiments on passive protection of irradiated rats demonstrated that immune serum with a high titer of smallpox antibodies had a strong protective effect. (BBB)

49535 RADIATION INJURY. Merz, Timothy (John Hopkins Medical Institutions, Baltimore). pp 722-41 of Principles of Nuclear Medicine. Wagner, Henry N. Jr. (ed.). Philadelphia, W. B. Saunders Co., 1968.

Biological responses to radiation are discussed under the following topics: the target; the effect of cell cycle stages on responses to radiation of somatic and germ cells; effects of intracellular radiation; the effects of dose, dose rates, and dose fractionation; modification of the response to radiation; environmental effects on radiation response; and late effects of irradiation. It is stressed that the kinds of damage observed in biological materials following irradiation are not peculiar to radiation injury, nor do they change qualitatively in relation to dose. The changes involve a shift in frequency of an event; the higher the dose, the more frequent the event. There is no documented threshold below which any biological response to radiation was shown not to occur. The effects of variations in dose schedules are complicated by repair mechanisms. 57 references. (M.M.B.)

49536 PASSAGE TIME OF PLUTONIUM OXIDE IN PIGS. Smith, V. H.; Ragan, H. A.; McClanahan, B. J.; Beamer, J. L.; Palotay, J. L. (Battelle Memorial Inst., Richland, Wash.). Contract AT(45-1)-1830. Monogr. Nucl. Med. Biol., No. 1, 518-23(Feb. 1968).

From Gastrointestinal Radiation Injury Symposium, Richland, Wash. See CONF-660917.

Ceramic plutonium oxide was fed as submillimeter, spherical particles to six pigs to determine the absorption of plutonium in the gastrointestinal tract. The earliest plutonium fecal excretion occurred two days after ingestion. Fifty percent of the plutonium in each pig was excreted by three to six days and 99% by six to 12 days after ingestion. Histopathological observations revealed damage throughout the small intestine with the greatest severity in the ileum. The cecum and colon exhibited very little damage. (M.M.B.)

49537 IRRADIATION OF THE GASTROINTESTINAL TRACT OF THE RAT BY INSOLUBLE BETA EMITTERS. Tuttle, L. W.; Rothe, W. E. (Tulane Univ., Covington, La.). Monogr. Nucl. Med. Biol., No. 1, 485-97(Feb. 1968).

From Gastrointestinal Radiation Injury Symposium, Richland, Wash. See CONF-660917.

The effects of ingestion of insoluble ^{32}P-labeled $CrPO_4$ on the gastrointestinal (GI) tract of rats were studied. Distribution of the radioactive particles was determined by autoradiographs of the uncoiled tract after gavage and quantitative study of ^{32}P distribution in measured segments of the intestinal tract. The characteristics, distribution, and flow of a single daily dose of ingested material of insoluble β emitters through the GI tract of the rat produce the following schedule of irradiation: the stomach is irradiated for about 12 hr; the small intestine, for 12 hr; the cecum and colon, for about 21 hr. A correlation of the dose-rate and biological effects leads to the assumption that the rat can tolerate the following dosages of radiation for 10 consecutive days with little or no immediate damage: stomach, 100 Rep per 24 hr; small intestine, 50 Rep per 24 hr; cecum, 25 Rep per 24 hr; and colon, 35 Rep per 24 hr. At the levels of radiation employed in these experiments the cecum and colon were found to suffer more severe histologic damage than the other segments of the tract. The condition of the cecal mucosa represents the most sensitive histologic indicator of radiation damage, while clinically a loss of body weight appears highly significant. A reduction of the number of circulating lymphocytes was not observed in the absence of some degree of intestinal lymphatic hypoplasia. (M.M.B.)

49538 ROLE OF THE INTESTINE IN ACUTE POSTIRRADIATION MORTALITY OF MICE. Vatistas, S.; Herdan, A.; Ellis, R. E. (St. Barthclomew's Hospital Medical Coll., London). Monogr. Nucl. Med. Biol., No. 1, 433-43(Feb. 1968).

From Gastrointestinal Radiation Injury Symposium, Richland, Wash. See CONF-660917.

Data are presented on the intestinal histology and survival of mice receiving radiation to either the intestine alone, whole-body, or whole-body with the intestine shielded. The results are used for evaluation of the assumptions that damage to the intestinal epithelium is the predominant cause of death after irradiation and that the survival of this tissue may be represented by the survival of animals at a particular time after irradiation. (M.M.B.)

49539 THE EFFECTS OF IONIZING RADIATION ON THE ENTEROCHROMAFFIN CELLS OF THE RAT, GUINEA PIG, AND SWINE GI TRACT. Lebreuil, G.; Thiery, G.; Masse, R.; Nizza, P. (Center for Nuclear Energy Studies, Fontenay-aux-Roses, France. French Atomic Energy Commission, Fontenay-aux-Roses, France). Monogr. Nucl. Med. Biol., No. 1, 444-51(Feb. 1968).

From Gastrointestinal Radiation Injury Symposium, Richland, Wash. See CONF-660917.

The effect of ^{60}Co γ radiation on the intestinal histology of the guinea pig, pig, and rat was studied. The occurrence of the intestinal radiation syndrome in rats was not associated with a concomitant increase in the serotonin-secreting Kultschitzky cells. However, the pig and guinea pig exhibited an increase in this cell type but did not show a typical intestinal syndrome radiation response. (M.M.B.)

49540 RATE OF DEVELOPMENT OF INTESTINAL DAMAGE IN THE GOLDFISH AFTER X-IRRADIATION AND MUCOSAL CELL KINETICS AT DIFFERENT TEMPERATURES. Hyodo-Taguchi, Y. (National Inst. of Radiological Sciences, Chiba, Japan). Monogr. Nucl. Med. Biol., No. 1, 120-6(Feb. 1968).

From Gastrointestinal Radiation Injury Symposium, Richland, Wash. See CONF-660917.

The effect of postirradiation temperatures on survival and intestinal damage was investigated in Carassium auratus. The uptake of tritium-labeled thymidine and the migration of labeled cells were studied in order to estimate the mitotic cycle time and life span of intestinal epithelial cells at different temperatures. Both the mitotic cycle and the life span were prolonged at lower temperatures. X irradiation did not result in a reduction of the initial rate of incorporation of labeled thymidine, however, the percentage of mitotic figures labeled and the rate of migration of labeled cells were modified by irradiation. It appears that the reduction of the number of epithelial cells after irradiation plays an important role in radioinduced intestinal death. The different renewal rate of the intestinal epithelium under different temperature conditions would explain why fish survive longer and exhibit fewer radiation lesions when kept at cool temperatures. (M.M.B.)

49541 ACUTE INTESTINAL RADIATION DEATH IN GERM-FREE AND CONVENTIONAL MICE. Wilson, R.; Bealmear, P.; Matsuzawa, T. (Univ. of Notre Dame, Ind.). Monogr. Nucl. Med. Biol., No. 1, 148-58(Feb. 1968).

From Gastrointestinal Radiation Injury Symposium, Richland, Wash. See CONF-660917.

Survival time was found to be longer and percentage survival greater in germfree than in conventional mice when mice that died within 30 days after whole-body x irradiation were compared. The hypothesis that survival time of animals exposed to whole-body irradiation in the gut death range is proportional to the life span of their intestinal mucosal cells was tested using tracer techniques. Conventional, germfree, monocontaminated, and exgermfree mice were whole-body x irradiated with 3000 R. Survival time, the fate of intestinal epithelial cells after irradiation, and the life span of epithelial cells in unirradiated animals were recorded. The average survival time of germfree mice was 7.3 days and the average life span of epithelial cells 4.3 days as compared to a survival time of 3.5 days and cell life span of 2.1 days for conventional mice. The monocontaminated and exgermfree mice gave figures between these extremes. The rate of cell turnover was greater in conventional mice than in germfree mice although the turnover percentage was the same. (M.M.B.)

49542 MUCOSAL CELL KINETICS IN PATIENTS EXPOSED TO ABDOMINAL IRRADIATION. Wiernik, G. (United Oxford Hospitals, Eng. Churchill Hospital, Oxford). Monogr. Nucl. Med. Biol., No. 1, 167-74(Feb. 1968).

From Gastrointestinal Radiation Injury Symposium, Richland, Wash. See CONF-660917.

The type and number of cells occupying each position in the jejunal crypt column were analyzed. Specimens were obtained during operation for peptic ulcer and after gastrectomy for carcinoma of the stomach. In one patient, series biopsies were obtained during a course of postoperative irradiation. In unirradiated patients the majority of the jejunal mucosa cells were epithelial cells in which there was no definite evidence of mitosis. Biopsy during irradiation revealed variations in mitotic activity and in the number of goblet cells. The radioinduced changes in cellular dynamics are discussed in terms of the long range effects of radiotherapy. (M.M.B.)

49543 ELECTROLYTE TRANSPORT AND VOLTAGE MEASUREMENTS IN A PREPARATION OF THE IRRADIATED RAT ILEUM. McKenney, J. R. (Battelle Memorial Inst., Richland, Wash.). Contract AT(45-1)-1830. Monogr. Nucl. Med. Biol., No. 1, 206-15(Feb. 1968).

From Gastrointestinal Radiation Injury Symposium, Richland, Wash. See CONF-660917.

The effects of x radiation and bile salts on the transport properties and potential differences across isolated rat ileum were studied in an attempt to identify the cause of radioinduced depression in the function of the mucosa. The data presented indicate that isolated intestine may be successfully used to perform definitive experiments on the mechanisms of injury caused by x irradiation and bile salts. The similarity of the effects of these agents also supports the possibility that the depression of fluid and electrolyte absorption after x irradiation may be in part secondary to a deleterious effect of bile salts on irradiated intestine. (M.M.B.)

49544 SODIUM, WATER, AND B_{12} ABSORPTION IN IRRADIATED RATS: INFLUENCE OF BILE. Sullivan, M. F. (Battelle Memorial Inst., Richland, Wash.). Contract AT(45-1)-1830. Monogr. Nucl. Med. Biol., No. 1, 216-27(Feb. 1968).

From Gastrointestinal Radiation Injury Symposium, Richland, Wash. See CONF-660917.

The effects of radiation and bile on intestinal function in rats were studied. Near-lethal (1000 R) and supra-lethal (1500 R) x ray doses resulted in marked decrease in water and sodium movement out of the lumen of the small intestine. Movement of sodium into the lumen from the blood was also affected by irradiation, but the results varied according to the technique of measurement. Absorption of vitamin B_{12} was decreased by irradiation. In experiments that did not utilize perfusion for measurement of transport, bile diversion appeared to prevent radioinduced malfunction of sodium transport. (M.M.B.)

49545 EFFECTS OF RADIATION AND DIARRHEA ON INTESTINAL ABSORPTION OF VITAMIN B_{12}. Okuda, K.; Fujii, M. (Kurume Univ. School of Medicine, Japan). Monogr. Nucl. Med. Biol., No. 1, 228-41(Feb. 1968).

From Gastrointestinal Radiation Injury Symposium, Richland, Wash. See CONF-660917.

Severe malfunction of the intestinal mucosa produced by lethal whole-body doses of x radiation did not have an immediate effect on B_{12} absorption by rats. Diarrhea induced by castor oil and sorbitol decreased absorption of B_{12} but $MgSO_4$-induced diarrhea slightly increased absorption. (M.M.B.)

49546 IN VIVO FAT ABSORPTION BY THE SMALL INTESTINE OF X-IRRADIATED MICE. Maisin, J. R.; Dulcino, J.; Deroo, J. (Center for Nuclear Energy Studies, Mol, Belg.). Monogr. Nucl. Med. Biol., No. 1, 251-60(Feb. 1968).

From Gastrointestinal Radiation Injury Symposium, Richland, Wash. See CONF-660917.

The absorption of glyceryltripalmitate-1-^{14}C and ^{14}C- or ^{3}H-palmitic acid by the small intestine of x-irradiated mice is reported. Possible radioprotective effects of aminoethylisothiuronium (AET) were investigated. One and three days after a dose of 1500 or 2500 R no significant differences were observed in the absorption of the fats. Cytological changes one day after irradiation were minor, but the mucosa was severely damaged after three days. There was a decrease in irradiated animals in the esterification of fatty acids to triglycerides in the small intestine wall and liver. These differences were smaller in AET protected animals. No large differences were noted in the fats in the wall of the small intestine of irradiated and unirradiated mice four hr after injection with glyceryltripalmitate-1-^{14}C. (M.M.B.)

49547 INTESTINAL MALABSORPTION IN PATIENTS UNDERGOING ABDOMINAL RADIATION THERAPY. Dalla Palma, L. (Univ. of Florence). Monogr. Nucl. Med. Biol., No. 1, 261-75 (Feb. 1968).

From Gastrointestinal Radiation Injury Symposium, Richland, Wash. See CONF-660917.

The behavior of intestinal absorption in patients undergoing abdominal therapeutic irradiation for genital neoplasia was studied. It was apparent that radiotherapy in the abdominal region was frequently accompanied by malabsorption of fats, sugars, iron, and vitamin B_{12}. (M.M.B.)

49548 INTERRELATIONS BETWEEN X IRRADIATION AND THE INTESTINAL FLORA OF MICE. Fritz, T. E.; Brennan, P. C.; Giolitto, J. A.; Flynn, R. J. (Argonne National Lab., Ill.). Monogr. Nucl. Med. Biol., No. 1, 279-91(Feb. 1968).

From Gastrointestinal Radiation Injury Symposium, Richland, Wash. See CONF-660917.

A strain of mice free of Pseudomonas aeruginosa, salmonella infection, and both ecto- and endoparasites was used in experiments designed to test interrelations between radiation and the intestinal flora. The relative numbers of lactobacilli, bacteroides, enterococci, coliforms, and micrococci in the intestines were not greatly altered by 700 or 900 R x irradiation except three days after the latter dose when the relative counts of bacteroides and enterococci were reversed. The coliform population decreased three days after 700 R, the micrococci increased by 10 days, and all species increased three days after 900 R. Proteus and Bacillus species were more numerous after all treatments than in controls. Mice irradiated with 500, 600, and 700 R ($^{30}LD_{50}$ was 680 R) were infected by gastric intubation with Citrobacter freundii. These mice had more micrococci and less coliforms than controls. The mice irradiated and infected all died earlier and in greater numbers than those similarly irradiated but not infected. (M.M.B.)

49549 GASTROINTESTINAL LESIONS IN AGED CONVENTIONAL AND GERMFREE MICE EXPOSED TO RADIATION AS YOUNG ADULTS. Cosgrove, G. E.; Walburg, H. E. Jr.; Upton, A. C. (Oak Ridge National Lab., Tenn.). Monogr. Nucl. Med. Biol., No. 1, 303-12(Feb. 1968).

From Gastrointestinal Radiation Injury Symposium, Richland, Wash. See CONF-660917.

A review is presented of the incidence and type of gastrointestinal (GI) lesions in irradiated and control mice involved in long-term survival experiments. Mice were irradiated at 9 to 12 weeks of age. Of the 13,318 mice exposed, 5083 were exposed to x rays, 3821 to γ rays, and 4414 to neutrons. Of 4008 control mice 5.6% had GI lesions compared to 4.0% of the irradiated mice. Neoplasms, however, had a higher incidence in irradiated mice; GI neoplasms occurred most frequently in neutron-irradiated mice and least frequently in x-irradiated; other lesions showed no difference in reference to type of radiation. More GI lesions occurred in irradiated LAF_1 mice than in irradiated RF and $1C3F_1$ strains. Leukemia and lymphoma incidence was also noted. In germfree mice the incidence of inflammatory lesions was reduced, but no differences were noted in the incidence of neoplasms and degenerative diseases. (M.M.B.)

49550 SEROTONIN AND RADIATION EFFECTS ON INTESTINE. Matsuoka, O.; Tsuchiya, T.; Kashima, M.; Eto, H. (National Inst. of Radiological Sciences, Chiba, Japan). Monogr. Nucl. Med. Biol., No. 1, 313-26(Feb. 1968).

From Gastrointestinal Radiation Injury Symposium, Richland, Wash. See CONF-660917.

Previous experiments showed that intestinal serotonin decreased after x irradiation and indicated a possible correlation between serotonin content and radiosensitivity in several species. Mouse and rabbit experiments are reported in which the effects of x radiation and serotonin on the intestine were determined. Ether and sodium pentobarbital, which appear to liberate serotonin from the intestine, produced a temporary depression of intestinal motility. Reserpine, a serotonin releaser, and 2-bromolysergic acid, a competitive inhibitor of serotonin, also inhibited motility. Continuous infusion of serotonin prevented the radioinduced depression in intestinal motility, but not intestinal damage and death at high doses. (M.M.B.)

49551 A COMPARISON OF DAMAGE TO THE SMALL INTESTINE BY FISSION NEUTRONS OR GAMMA RAYS FROM ^{60}Co. Vogel, H. H. Jr.; Jordan, D. L. (Argonne National Lab., Ill.). Monogr. Nucl. Med. Biol., No. 1, 327-30(Feb. 1968).

From Gastrointestinal Radiation Injury Symposium, Richland, Wash. See CONF-660917.

Mice were exposed to single whole-body lethal and supralethal doses of fission neutrons or ^{60}Co γ rays. Damage to the small intestine was determined in terms of loss of weight and length the fourth day after exposure. The RBE (n/γ) for intestinal weight loss was calculated as 4.33 over the entire dose range. (M.M.B.)

49552 EARLY EFFECTS OF 14.1-MeV NEUTRON IRRADIATION ON INTESTINAL MUCOSA. Hirose, F. (Hiroshima Univ.). Monogr. Nucl. Med. Biol., No. 1, 331-41(Feb. 1968).

From Gastrointestinal Radiation Injury Symposium, Richland, Wash. See CONF-660917.

Rats and mice were exposed to various doses of 14.1 MeV neutrons. The effects on blood, DNA content in the intestine, and histology of intestinal mucosa and bone marrow were observed. The effects on intestinal mucosa are described and compared with the effects of γ rays and x rays. (M.M.B.)

49553 ACUTE INTESTINAL RADIATION DEATH IN THE GUINEA PIG. Willhoit, D. G. (Univ. of North Carolina, Chapel Hill). Monogr. Nucl. Med. Biol., No. 1, 342-9(Feb. 1968).

From Gastrointestinal Radiation Injury Symposium, Richland, Wash. See CONF-660917.

Guinea pigs were exposed to fission neutrons or x rays. Body weight changes, time distributions of deaths, mean survival times, and histological findings are reported. Fission neutron exposures of 44 and 75 hectoergs/g were effective in producing a gastrointestinal syndrome in guinea pigs. The effects of neutrons are compared to those of x irradiation. (M.M.B.)

49554 MECHANISM OF INTESTINAL RADIATION DEATH. Panel Discussion. Monogr. Nucl. Med. Biol., No. 1, 351-73 (Feb. 1968).

From Gastrointestinal Radiation Injury Symposium, Richland, Wash. See CONF-660917.

V. P. Bond of Brookhaven National Laboratory moderated a panel discussion in which each panel member summarized a particular aspect of the mechanism of intestinal radiation death after which there was an open discussion. S. Hornsey of Hammersmith Hospital summarized radiosensitivity in mammals, S. Lesher of Argonne National Laboratory described the radioinduced sequence of events in intestinal mucosa cells, C. C. Lushbaugh of Oak Ridge Associated Universities, Inc. presented data to support his contention that whole-body electrolyte loss through a leak in the gastrointestinal (GI) tract cannot be the underlying biochemical mechanism in the GI syndrome. J. W. Osborne of the University of Iowa discussed the role of bile in radioinduced intestinal injury. (M.M.B.)

49555 NECTURUS MACULOSUS AS AN EXPERIMENTAL ANIMAL TO STUDY CELLULAR INJURIES OF THE IRRADIATED GUT IN VIVO. Prasad, Kedar N. (Brookhaven National Lab., Upton, N. Y.). Monogr. Nucl Med. Biol., No. 1, 377-84(Feb. 1968).

From Gastrointestinal Radiation Injury Symposium, Richland, Wash. See CONF-660917.

Because the cell population in the irradiated intestine of rats changes very rapidly after exposure, any physiological or biochemical measurements in vivo reflect the number of cells remaining at that time and not necessarily a change in function of cells present during irradiation. In the amphibian Necturus maculosus the cell turnover of small intestine and the progression of radiation lesion in the mucosa are very slow. This animal provides an opportunity to study the radiation damage in cells present during exposure. The histology of the small intestine of Necturus was similar to that of rats except that the crypts were more basophilic and did not show mitotic figures. Labeling of epithelial cells with tritium-labeled-thymidine did not occur three hr or three days after injection. All animals survived 30 days after a 50 kR x irradiation of the abdomen, but only 25% survived 30 days after 150 kR. Eleven days after 150 kR the cells lining the villi in the small intestine were decreased in number, swollen, and exhibited nuclear fragmentation. (M.M.B.)

49556 INTESTINAL VASCULAR CHANGES IN THE ACUTE RADIATION INTESTINAL SYNDROME. Eddy, H. A.; Casarett, G. W. (Univ. of Rochester, N. Y.). Contract W-7401-eng-49. Monogr. Nucl. Med. Biol., No. 1, 385-95(Feb. 1968).

From Gastrointestinal Radiation Injury Symposium, Richland, Wash. See CONF-660917.

The histological and microangioradiographic changes were studied in the blood vasculature of the small intestine of rats killed at daily intervals or allowed to die spontaneously after a single 1460 R dose of whole-body x irradiation to the temporarily exteriorized intestine sufficient to cause acute radiation intestinal death. There was an apparent relation between the degree and rate of development of radiation damage in the intestinal mucosa and the development of obstructive changes in the fine vasculature. (M.M.B.)

49557 GUT LEAKAGE AND INTESTINAL DEATH AS A MEASURE OF RADIATION DAMAGE: RBE VALUES FOR NEUTRONS AND THE EFFECTS OF FRACTIONATION. Hornsey, S.; Vatistas, S. (Hammersmith Hospital, London. St. Bartholomew's Hospital Medical Coll., London). Monogr. Nucl. Med. Biol., No. 1, 396-400(Feb. 1968).

From Gastrointestinal Radiation Injury Symposium, Richland, Wash. See CONF-660917.

Experiments were conducted on mice to determine whether protein leakage through the intestinal wall might result from radioinduced epithelial damage. Leakage of ^{131}I-labeled polyvinylpyrrolidone was measured after neutron- and x-irradiation. Consideration of the times at which radioinduced protein leakage and epithelial damage occurred, the differing physiological effects of x rays and neutrons, and the effects of fractionation led to the conclusion that the two types of damage were not closely related. (M.M.B.)

49558 LYSOSOME ACTIVITY IN RADIATION INDUCED INTESTINAL INJURY. McFadyen, D. M.; Baker, D. G. (Brookhaven National Lab., Upton, N. Y.). Monogr. Nucl. Med. Biol., No. 1, 401-12(Feb. 1968)

From Gastrointestinal Radiation Injury Symposium, Richland, Wash. See CONF-660917.

The presence and distribution of β-glucuronidase and acid phosphatase in rat intestine were analyzed after a sublethal dose of x radiation. The results showed a correlation between soluble enzyme activity and degree of intestinal damage. A rapid disappearance of the hydrolases after a gradual buildup apparently reflects a more important role of lysosomes in injury and degradation than in recovery from radiation. (M.M.B.)

49559 ROLE OF INTESTINAL INJURY IN 30-DAY RADIATION LETHALITY OF WEANLING MICE. Fred, S. S.; Wilson, S. M.; Smith, W. W. (National Cancer Inst., Bethesda, Md.). Monogr. Nucl. Med. Biol., No. 1, 413-20(Feb. 1968).

From Gastrointestinal Radiation Injury Symposium, Richland, Wash. See CONF-660917.

Weanling and adult mice were given LD-equivalent doses of γ radiation. Damage to the gastrointestinal tract and hemopoietic damage appeared to be jointly responsible for the death of weanling mice given less than supralethal irradiation. Weanling mice were not completely protected by bone marrow injections. They died earlier than adults given equivalent doses and lower doses were required by weanlings to cause death associated with gastrointestinal damage. Greater intestinal damage was seen in weanlings than adults at doses associated with death from hemapoietic damage. (M.M.B.)

49560 EFFECTS OF SINGLE-DOSE, WHOLE-BODY IRRADIATION ON THE MOUSE DUODENAL CRYPT CELLS. Lesher, S. (Argonne National Lab., Ill.). Monogr. Nucl. Med. Biol., No. 1, 103-10(Feb. 1968).

From Gastrointestinal Radiation Injury Symposium, Richland, Wash. See CONF-660917.

The labeled mitosis method was used to determine the effect of 300 R γ-ray exposure on cells in the various stages of the cell cycle. Cells in all phases are damaged by ionizing irradiation; cells in some phases, however, are either more sensitive (e.g., G_2 and M) or the damage is repaired before the cell attempts division and becomes detectable. The initial reaction to radiation may be basically the same, in terms of the type of damage produced, in all proliferative cell populations in vivo or in vitro, but the in vivo environment elicits compensatory responses that have not been detected in the in vitro cell populations. During the recovery phase, when killed and less damaged cells are being replaced in mammalian tissue, two compensatory mechanisms hasten the return to a normal steady-state relationship that exists between the proliferative and nonproliferative cells: acceleration of the generation cycle, and increase in the number of cells in the proliferative compartment. (M.M.B.)

49561 EFFECT OF BILE ON THE MUCOSA OF THE SMALL INTESTINE. Mahony, T. D.; Berlin, J. D.; Pekas, J. C.; Sullivan, M. F. (Battelle Memorial Inst., Richland, Wash.). Contract AT(45-1)-1830. Monogr. Nucl. Med. Biol., No. 1, 42-56(Feb. 1968).

From Gastrointestinal Radiation Injury Symposium, Richland, Wash. See CONF-660917.

Observations were made by both light and electron microscopy of the effects of bile duct cannulation and x irradiation on the intestinal morphology of pigs and rats. In unirradiated animals diversion of bile for several days resulted in an increase in the proportion of goblet cells in the mucosa. In irradiated animals with bile fistula an increase in size and number of goblet cells occurred. Although no differences were observed in the luminal surfaces of goblet cells between normal animals and those with bile fistula, there was an increase in thickness in the surface mucopolysaccharide coat after both bile fistula and irradiation. An increase in the coliform count occurred after both bile diversion and irradiation. The role of the bacterial flora in the observed mucosa changes is discussed. (M.M.B.)

49562 EFFECTS OF X-RAY THERAPY ON THE MORPHOLOGY OF THE MUCOSA OF THE HUMAN SMALL INTESTINE. Trier, J. S.; Browning, T. H.; Foroozan, P. (Veterans Admin-

istration Hospital, Madison, Wis. Univ. of Wisconsin, Madison). Monogr. Nucl. Med. Biol., No. 1, 57-72(Feb. 1968).

From Gastrointestinal Radiation Injury Symposium, Richland, Wash. See CONF-660917.

A study was made of the morphological and functional changes induced in human intestinal mucosa by therapeutic doses of x radiation. A distinct lesion was found in the mucosa region within the field of radiation exposure. This lesion was characterized by a decrease in mitotic activity and megalocytosis of epithelial cells, by a decrease in absorptive surface of the bowel, and by increased infiltration of the lamina propria with inflammatory cells and plasma cells with occasional crypt abscess formation. This mucosal lesion seemed to heal rapidly and completely after cessation of x-ray treatment in the dosages employed here. That the mucosal lesion seemed limited to the bowel directly exposed to radiation was supported by the absence of detectable morphological changes in the biopsies obtained from unexposed bowel lying outside of the field of therapy in two patients undergoing abdominal radiation, by the surprising lack of significant GI symptoms in the patients, and by the absence of clinically evident malabsorption. When absorption of the irradiated segment of bowel was measured by intraluminal perfusion techniques, however, the absorptive capacity of the involved segment was clearly impaired. (M.M.B.)

49563 EFFECT OF RADIATION ON ULTRASTRUCTURE AND ENZYMES OF THE CANINE PANCREAS. Volk, B. W.; Wellmann, K. F. (Isaac Albert Research Inst., Brooklyn). Monogr. Nucl. Med. Biol., No. 1, 73-93(Feb. 1968).

From Gastrointestinal Radiation Injury Symposium, Richland, Wash. See CONF-660917.

Various effects of radiation were studied in partially pancreatectomized dogs that were sacrificed at various intervals after a single dose (5000 to 9000 R) of x radiation to the exteriorized residual portion of the pancreas. Serum lipase activity declined after irradiation, but serum leucine aminopeptidase and amylase were unaltered. All three of these enzymes were lower in the tissue in irradiated dogs than in the controls. The weight loss of irradiated dogs was twice that of the controls. No significant hematological differences were seen between irradiated and control dogs. Blood sugar and glucose tolerance values remained normal in irradiated and unirradiated dogs. Ultrastructural changes in the pancreas occurred in three major phases. The initial phase covered three to four weeks after irradiation, although some manifestations remained for months. It was characterized by extensive cellular damage highlighted by the sequestration and subsequent degradation of large areas of the cytoplasm. The second phase reached its climax during the third month after irradiation and mainly exhibited changes in the endoplasmic reticulum which increased in mass and appeared to be involved with restitution of cellular functions. The final phase was reached during the sixth to ninth month after irradiation and was characterized by normalization of the ultrastructure of the pancreatic acinar cell. (M.M.B.)

49564 GASTROINTESTINAL RADIATION INJURY. Report of a Symposium Held at Richland, Wash., September 25–28, 1966. Sullivan, M. F. (ed.). Monographs on Nuclear Medicine and Biology No. 1. New York, Excerpta Medica Foundation, 1968. 542p. (CONF-660917).

Separate abstracts are presented on 39 of the papers in this conference. They deal with such topics as mechanisms of intestinal radiation injury and death, intestinal injury from internal emitters, radioprotective substances, radiation effects on structure and functions of the intestinal tract, sorption and transport of radioisotopes in the intestine, and dosimetry of absorbed internal emitters. Seven other papers in the conference deal with tracer techniques in studying intestinal physiology, electric potential and fluid transfer in intestines, physiology of intestinal absorption, and gastro intestinal transit times. Discussions follow each paper and subject area. (E.R.B.)

For abstracts of individual papers see: 49225–49229, 49331–49333, 49412–49414, and 49536–49563.

49565 FATTY ACID PATTERN OF FOETAL AND MATERNAL PLASMA LIPIDS AND ITS CHANGES FOLLOWING TOTAL BODY IRRADIATION OF THE MATERNAL ANIMAL WITH 800 R IN RATS. Winkler, L.; Goetze, E. (Friedrich-Schiller-Univ., Jena, Ger.). Acta Biol. Med. Ger., 20: 545-51(1968). (In German).

Twenty-four hours after whole-body x irradiation of pregnant rats (day 19 of pregnancy) cholesterol esters, triglycerides, and phospholipides of the fetal and maternal plasma were tested by gas chromatographic procedure for fatty acid pattern. Sham-irradiated animals at the same stage of pregnancy served as controls. Fetal plasma lipids were characterized by a greater proportion of monoenic acid ($C_{18:1}$, $C_{18:1}$) and a smaller proportion of polyenic acid ($C_{18:2}$, $C_{20:4}$) versus maternal fractions. Greatest differences were observed in the cholesterol fraction. The proportion of stearic acid was higher in the fetal plasma neutral fats, and phosphatides was lower than that of the mother. The fatty acid pattern of fetal plasma cholesterol esters departed from that of the fetal liver cholesterol esters. The level of linolic acid in fetal plasma triglycerides, and the level of arachidonic acid in fetal plasma phospholipids were doubled under irradiation; further, irradiation caused a slight but significant increase in linolic acid and a small, also significant decrease of oleic acid in the fetal plasma phospholipids, and also caused a small but significant fall of palmitoleic acid in fetal cholesterol esters. In maternal plasma lipids, irradiation produced only a significant decrease in linolic acid in plasma cholesterol esters. The findings are compared with the fatty acid pattern in the liver. (auth)

49566 RECURRENT NECK MASS FOLLOWING IRRADIATION OF HODGKIN'S DISEASE. Moon, John H.; Hudson, Page (Medical Coll. of Virginia, Richmond). Va. Med. Mon., 95: 31-40(Jan. 1968).

The development of papillary carcinoma of the thyroid induced by x- and ^{60}Co γ-irradiation of the neck region for treatment of Hodgkin's disease was described. The patient received a dose of 3000 R of x irradiation in 1959, 3000 R in 1962, and 3800 R in 1963. The onset of the thyroid carcinoma occurred in 1965. The patient's age was 25 at this time. The frequency of development of thyroid carcinoma in children and young patients is from 8 to 40 times the incidence in control patients. The patient studied was 19 at the time of the initial irradiation. (BBB)

49567 SUPRALETHAL TOTAL-BODY X IRRADIATION. EFFECTS ON THE SPINAL CORD OF PARABIONT RATS. Kury, George; Warren, Shields; Chute, Rosanna N. (New England Deaconess Hospital, Boston). Arch. Neurol., 18: 703-7(June 1968).

The effects of supralethal whole-body x irradiation on the neurons of the spinal cord of parabiotic rats were studied. A total of 2000 pairs of rats were parabiosed, using litter-mates of the same sex. The right-hand partner of the experimental pairs received 1000 R of whole-body x irradiation (at a rate of 40 to 80 R/min) measured in air at 250 KVp and 15 mA (1250 rad total). The right-hand partner that received 1000 R whole-body irradiation had significantly fewer pyramidal cells than any of the controls. The irradiated partner had a mean of 113.1 ± 3.7 per cross section of the cord, whereas the left-hand control showed 121.8 ± 4.3. In the unirradiated parabiont controls, the mean number of pyramidal cells was 132.2 ± 5.6 for the right-hand partner and 118.2 ± 4.1 for the left-hand partner. Histologic examination revealed other mild changes in many of the irradiated animals. There was slight to moderate thickening of the walls of blood vessels in the white or gray matter of the cord in many animals. No gliosis was found in either the irradiated or the control animals. The intraspinal and meningeal blood vessels did not show sufficient radiation damage to impair blood supply. The loss of pyramidal cells in the spinal cord was assumed to be caused by direct effects of x irradiation on neurons. (BBB) (TSS)

49568 HISTOLOGY OF RETINAL LESIONS PRODUCED WITH Q-SWITCHED LASERS. Marshall, J.; Mellerio, J. (Inst. of Ophthalmology, London). Exp. Eye Res., 7: 225-30(Apr. 1968).

The histology of retinal lesions induced by a Q-switched ruby laser was studied. Lesions with very large pre-retinal hemorrhages could be produced. However, neutral filters were usually placed in the beam to permit delivery of energy doses from below to well above threshold. A calculated retinal energy density of ~0.6 J/cm^2/spike was usually employed to produce lesions that were normally above threshold for one or two spikes and ~400 μ in dia. The age of the lesions ranged from 2 min to 2 months. The lesions did not show a pigment ring and gas bubble, but could be divided into two concentric areas, an inner area of retinal breakdown and an outer area of less severe effects. A trapped subretinal hemorrhage was a feature of the lesions immediately above the energy threshold, and with larger energy doses the retina broke down and the blood passed into the vitreous. There was a delay in the onset of macrophage activity not noted in passive laser lesions. At present Q-switched lasers are unsuitable for retinal surgery because of the delay in healing and small amount of scar tissue formed. (BBB) (TSS)

49569 ON THE PRESENCE OF PERIPHERAL-LIKE NERVOUS AND CONNECTIVE TISSUE WITHIN IRRADIATED SPINAL CORD. Gilmore, Shirley Ann; Duncan, Donald (Univ. of Arkansas, Little Rock). Anat. Rec., 160: 675-89(1968).

Cells with elongated nuclei resembling those of fibroblasts and/or Schwann cells were noted previously in x-irradiated rat spinal cord. An experiment was undertaken to determine the identity and fates of these cells. A 5 mm length of lumbosacral spinal cord was x-irradiated (4000 R) in 3-day old Holtzman rats, which were

killed at intervals from 11 through 60 days later. Light microscopic examination revealed that the cells in question became observable near the dorsal roots within and immediately caudal to the irradiated area in a few rats as early as 15 days postirradiation and in all rats by 19 days. The number of cells increased rapidly and in some cases filled the dorsal funiculi. Axons that were intermingled with these cells usually became myelinated about 25 days postirradiation. The myelin that formed on these axons resembled peripheral rather than central myelin. Reticular fibers were also abundant in the cell aggregations. Ultrastructural studies confirmed these observations. The results indicate that these cells were involved in formation of peripheral-like nervous tissue within the spinal cord of all irradiated rats. (BBB)

49570 EFFECTS OF EXTERNAL AND INTERNAL IRRADIATION ON SHEEP RESISTANCE TO CAUSATIVE AGENTS OF BABESIASIS. **Duranov, V. S.; Abramov, I. V. Veterinariya, 42: 41-4 (Dec. 1965). (In Russian).**

Experiments were conducted in four series in 30 sheep. In the first series, eight healthy sheep were used (4 controls), of which four received 810 R of whole-body radiation with 180-kV x rays at 13.5 R/min. Two irradiated and of two nonirradiated (control) sheep were simultaneously infested with ten pairs of fasted ticks containing Babesiella ovis. All irradiated sheep developed radiation sickness 31 days later. The other two of the four irradiated sheep and two of the control sheep were also infested with ten pairs of babesia ticks, on 36th and 85th day after irradiation, respectively. All sheep infested with ticks (some were inoculated with 40 ml of blood of infested sheep) developed babesiasis 12 to 14 days later and subsequently were treated with azide preparations. The other three experimental series included 22 healthy sheep which were inoculated with babesiasis agents and then received daily doses of ^{90}Sr in a concentrated oats and barley food. Hematological and clinical studies revealed that the resistance of sheep to babesiasis was greatly impaired as a result of the external (x ray) and internal (^{90}Sr) preirradiation. The course of their disease was severe and its outcome was fatal in all cases. However, previously irradiated, babesiasis-infected sheep responded well to the treatment with azide preparations. Lambs born of sheep fed with ^{90}Sr developed severe babesiasis with a fatal outcome just as their mothers. Even the offspring, born 24 to 27 months after their mothers ceased to receive ^{90}Sr in food, were slightly infected with babesiasis. It was also found that x-irradiated babesiasis-infected sheep failed to develop a recurrent infection, however, their parasitic symbiosis persisted. (BBB)

49571 STUDIES OF THE MECHANISM OF ULTRAVIOLET ERYTHEMA FORMATION. V. CHANGES IN THE FINE STRUCTURE OF MAST CELLS OF THE SKIN DURING THE PROCESS OF ULTRAVIOLET ERYTHEMA CAUSED BY WAVEBAND UV-C. **Valtonen, Erkki J. (Univ. Central Hospital, Helsinki). Acta Dermato-Venereol., 48: 203-11 (1968).**

Changes in the fine structure of the mast cells of the skin during uv-induced erythema in mice were examined. In the external ear, mild erythema was induced by irradiating the skin with short wavelength (2537 Å) radiation, so-called UV-C, and the degree of the erythema was continuously recorded according to defined criteria. Skin samples were taken at intervals between 0.5 and 18 hr after irradiation and examined with an electron microscope. Changes in the fine structure of the mast cells followed a characteristic course during the process of erythema, the main features of the process being edema of the cytoplasm, fading and disappearance of the granules, and, in the final phase, hypertrophy of the endoplasmic reticulum. The relations between morphologic changes in the mast cells and the chemical process caused by uv radiation are discussed. (BBB)

49572 AMINO-SUGAR ESTIMATIONS AS A METHOD FOR DISTINGUISHING BETWEEN LUNG DAMAGE CAUSED BY TUMORS AND BY RADIATION. **Kaercher, K. H.; Stauch, G. (Czerny Krankenhaus, Heidelberg). Ger. Med. Mon., 12: 447-8 (Sept. 1967). (In English and German).**

A biochemical method for distinguishing radioinduced pneumonia and fibrosis from lymphangitis carcinomatosis is described. In 22 patients with radiation pneumonia, radiation fibrosis, or lymphangitis carcinomatosis there was a sharp rise in the protein-bound serum hexose level when the pneumonic changes were at their height. As the lung changes progress towards organization and fibrosis hexoses, hexosamines, and seromucoids are elevated to roughly the same extent, while in lymphangitis carcinomatosis there is a considerable increase in hexoses as compared with hexosamines and seromucoids. Estimations of serum hexoses, hexosamines, and seromucoids may be of some value in the differential diagnosis of radiation pneumonia and fibrosis from lymphangitis carcinomatosa when radiological examination fails to give an unequivocal answer. (BBB)

49573 RETINAL VASCULAR CHANGES FOLLOWING EXPOSURE TO HIGH-INTENSITY LIGHT. **Kohner, Eva M.; Dollery, C. T.; Henkind, Paul; Paterson, J. W.; Ramalho, P. S. (Postgraduate Medical School, London). Amer. J. Ophthalmol., 63: 1748-61 (June 1967).**

Recent interest on retinal damage caused by high intensity light has centered on two sources: atomic explosions and the laser. Only one case of blindness was reported following the explosion of the atomic bomb at Hiroshima but accidental injury resulting in some permanent damage in humans was reported in nuclear tests. Retinal burns produced by high intensity light from a Xe lamp in pigs was studied. Visible retinal lesions were documented by color photography and dynamic circulatory changes by fluorescence angiography. There was a graded response to the high-intensity light that depended not only on the length of exposure but also on the different animals. On color photography in shorter exposures, there was no change. In mild burns, pigment disturbances and shrinkage were observed. In the more severe burns there was in addition edema, hemorrhage and destruction of normal retina. Angiography showed damage to capillaries and larger vessels before visible changes appeared on color photography. In the more severely damaged retinas, there were flow changes, functional changes, and destruction of vessels. (BBB)

49574 SURVIVAL OF LYMPHATIC CELLS AFTER X-IRRADIATION IN MICE. Vos, O. (National Defense Research Organization TNO, Rijswijk, Netherlands). pp 134-48 of Effects of Ionizing Radiations on the Haematopoietic Tissue. Vienna, International Atomic Energy Agency, 1967.

See STI/PUB-134.

Radiation mouse chimeras were used to determine the x-radiosensitivity of lymphatic cells; technical details and procedures are outlined. Data are reported from experiments on sensitivity of lymph node cells x-irradiated in vitro, in the donor, and in the recipient; effects of delay of irradiation after antigen injection on lymph node cells in the recipient; effects of choice of survival time of treated mice on determination of survival percentage of lymph node cells; effect of anoxia on radiosensitivity of lymph node cells; recovery of lymphocytes from radiation damage; and the radiosensitivity of lymphatic cells from sources other than the lymph nodes. (B.S.L.)

49575 RADIATION EFFECTS ON GRANULOCYTE FORMATION AND MATURATION IN VARIOUS SPECIES AND AT DIFFERENT LEVELS OF EXPOSURE. Fliedner, T. M. (Euratom, Freiburg i. B.). pp 126-33 of Effects of Ionizing Radiations on the Haematopoietic Tissue. Vienna, International Atomic Energy Agency, 1967.

See STI/PUB-134.

The following aspects of granulocytopoiesis were reviewed: pattern of development of granulocytopenia as a function of exposure level and of species; comparison of granulocyte depression; and appearance and disappearance of granulocytes with mitotically connected abnormalities as a possible indicator of radiation effects on the proliferative pool. From comparison studies in man, dogs, rabbits, rats, and mice it was concluded that the pattern of granulocyte changes after whole-body exposure was the same in principle; consequent increase and decrease of the granulocyte blood concentration was related to exposure level. There was no evidence for non-dividing, mature elements being affected by radiation directly; injured cells appeared in the pool only after some precursor cells had undergone cell division or matured without division. Depending on the degree of damage in the proliferation pool, the granulocytes of the blood decreased. The several types of injured cells that may be found are discussed; several populations of giant cells that must be distinguished are mentioned. (B.S.L.)

49576 THE USE OF RADIOACTIVE IRON IN STUDYING THE RESPONSE OF ERYTHROPOIETIC TISSUE TO WHOLE-BODY IRRADIATION. Blackett, N. M. (Institute of Cancer Research, Surrey, Eng.). pp 119-25 of Effects of Ionizing Radiations on the Haematopoietic Tissue. Vienna, International Atomic Energy Agency, 1967.

See STI/PUB-134.

Results using ^{59}Fe and bone marrow transplantation that make it possible to suggest a possible explanation for the maintenance of erythropoiesis in rats irradiated continuously at 45 rads/d are presented. Some of the problems concerning the relation between repopulating ability and stem cell numbers are discussed. Two methods that do not use bone marrow transplants for measuring stem cells are briefly mentioned. (B.S.L.)

49577 THE EFFECT OF X-IRRADIATION, ^{60}Co- GAMMA AND MIXED NEUTRON-GAMMA IRRADIATION ON THE INCORPORATION OF ^{59}Fe INTO THE MOUSE ERYTHROPOIETIC SYSTEM. **Sztanyik, B. L. (National Inst. for Radiobiology**

and Radiohygiene, Budapest). pp 111-18 of Effects of Ionizing Radiations on the Haematopoietic Tissue. Vienna, International Atomic Energy Agency, 1967.
See STI/PUB-134.

The effects of x radiation, ^{60}Co γ-rays, and mixed neutron-γ radiation from an atomic pile on ^{59}Fe uptake by the erythropoietic systems of mice were compared. Incorporation of the ^{59}Fe into erythrocytes, hematopoietic tissues (bone marrow), and depot organs (spleen, liver, and kidneys) served as the basis for comparison. Mice x-irradiated at doses of 25 to 600 R were injected with ^{59}Fe 24 hr after exposure and the activity of the blood was determined 1 to 8 days postinjection; ^{59}Fe uptake by erthrocytes was depressed and the rate of depression depended on the dose. It was established for mice irradiated with x or neutron-γ radiation that the inhibition of ^{59}Fe uptake depended on the absorbed dose and on the interval between irradiation and isotope administration. At identical absorbed doses, neutron-γ irradiation impaired erythropoiesis far more markedly than x radiation. It was concluded that the 72 hr incorporation of intravenously administered ^{59}Fe into newly formed erythrocytes was a suitable index for characterization of erythropoietic activity in irradiated mice. Iron-59 uptake for hematopoietic tissues, depot organs, and other tissues proved to be less reliable indexes. (B.S.L.)

49578 COMPARISON OF HAEMATOLOGICAL RESPONSES AND RADIATION RECOVERY IN SEVERAL MAMMALIAN SPECIES. Alpen, E. L. (Naval Radiological Defense Lab., San Francisco, Calif.). pp 103-10 of Effects of Ionizing Radiations on the Haematopoietic Tissue. Vienna, International Atomic Energy Agency, 1967.
See STI/PUB-134.

A long-term systematic comparison was made of the hematological response, the lethal dose (LD_{50}), and the recovery kinetics of a number of γ- or x-irradiated mammals that broadly represented the animal kingdom in size, dietary habits, life span, and normal hematology. The animals included in the study were dogs, mice, rats, hamsters, guinea pigs, rabbits, monkeys, swine, sheep, goats, and burros. The hematological response of the larger animals was distinctly different from that of the small animals in that the granulocyte count was generally slower to fall and rise of the peripheral count was remarkably slower. The mean survival time of the larger animals was also generally more prolonged than that for the smaller species. It was established that large differences existed when the radiosensitivity of a number of species was compared and that recovery patterns were complex and bore little relation to radiosensitivity or the hematological state. It was concluded that generalizations relative to acute radiosensitivity or recovery could not be made. (B.S.L.)

49579 HAEMATOLOGICAL EFFECTS OF TOTAL OR PARTIAL IRRADIATION OF THE HUMAN ORGANISM. Tubiana, M. (Institut Gustave Roussy, Seine, France). pp 87-99 of Effects of Ionizing Radiations on the Haematopoietic Tissue. Vienna, International Atomic Energy Agency, 1967. (In French).
See STI/PUB-134.

The effects of γ radiation on hematopoiesis in man undergoing kidney transplants were investigated; doses varied between 600 and 50 rads. In general, the larger the dose received, the faster was recovery when it began. Thymectomy and splenectomy had no apparent effect on the recovery generation of granulocytes, thrombocytes, and reticulocytes. (B.S.L.)

49580 HAEMATOLOGICAL EFFECTS OF WHOLE-BODY RADIATION IN THE HUMAN BEING. Andrews, G. A.; Lushbaugh, C. C.; Kniseley, R. M.; White, D. A.; Friedman, B. I. (Oak Ridge Inst. of Nuclear Studies, Inc., Tenn. Oak Ridge Associated Universities, Inc., Tenn. Cincinnati Univ., Ohio). pp 75-83 of Effects of Ionizing Radiations on the Haematopoietic Tissue. Vienna, International Atomic Energy Agency, 1967.
See STI/PUB-134.

The effect of whole-body γ-irradiation, applied for therapeutic purposes, on the hematopoietic tissues of man was investigated. Three groups were studied: those with chronic hematologic disorders (polycythema vera, chronic leukemia) exposed to 50 and 100 R; those with various types of advanced cancer exposed to a range of 100 to 475 R; and those with acute leukemia given exposures of from 206 to 384 R. The small group of patients with non-hematologic malignancies that most nearly approximated the normal hematologic state showed the expected pattern of prompt depression of lymphocytes and slower depression of granulocyte elements. It was concluded that the results showed that patients with hematological diseases had considerable variance in the degree of response to the same dose, depending upon the disease state. There was no evidence for any increased resistance to radiation damage in any of the diseases, but there was evidence of increased sensitivity in leukemic states. (B.S.L.)

49581 BONE-MARROW STEM-CELL SURVIVAL IN THE NON-UNIFORMLY EXPOSED MAMMAL. Bond, V. P.; Robinson, C. V. (Brookhaven National Lab., Upton, N. Y.). pp 69-74 of Effects of Ionizing Radiations on the Haematopoietic Tissue. Vienna, International Atomic Energy Agency, 1967.
See STI/PUB-134.

A biological model designed for comparison of the effectiveness of non-uniform versus uniform irradiation in causing hematological death in mammals is briefly described. The validity of this stem-cell survival model was tested using two sets of data; one in which the lethal effects of bilateral versus unilateral exposure of dogs to 1000 kvp x rays were compared, and one in which rats were exposed non-uniformly to ^{60}Co γ rays. The model served to clarify what dose parameters may or may not be useful in normalizing biological effectiveness (lethality) for a variety of radiations of different qualities, or a single radiation delivered with different depth dose distributions. It was concluded that no single physical dose parameter was suitable to express the lethal capacity of radiations delivered non-homogenously. (B.S.L.)

49582 POST-IRRADIATION CHANGES IN THE BONE MARROW AND PERIPHERAL BLOOD. Dienstbier, Z.; Arient, M.; Pospisil, J. (Charles Univ., Prague). pp 60-8 of Effects of Ionizing Radiations on the Haematopoietic Tissue. Vienna, International Atomic Energy Agency, 1967.
See STI/PUB-134.

The quantitative dynamics of the cellularity of bone marrow following x irradiation at doses of 25, 100, 600, and 1000 R, after the administration of ^{32}P, ^{51}Cr, ^{65}Zn, ^{198}Au, and following external irradiation and simultaneous administration of internal emitters were studied in detail. Data on absolute changes in normoblasts and myeloid elements and relative changes in leukocyte and lymphocyte counts are presented in graphic form. The analysis of the change of absolute counts of bone marrow cells demonstrated that the erythroid elements were less resistant to radiation following external whole-body irradiation as well as after internal contamination by radioisotopes; their decreased count in the early phase was proportional to the absorbed dose of radiation. The absolute analysis of bone-marrow changes showed that even the reaction of myeloid cells and normoblasts after the application of internal emitters was not quantitatively different from the biological response to external irradiation. Reticulocytes increased absolutely after external irradiation and decreased after the application of radioisotopes. In the combined external and internal irradiation, an absolute decrease in all kinds of bone marrow cells was noted; the kind of internal emitter used had no effect. Relative changes in lymphocyte counts showed that the lymphocytes were the most sensitive of the peripheral blood elements. (B.S.L.)

49583 CONTROL OF HAEMOPOIESIS AND THE ACTION OF ADIATION ON THE BLOOD-FORMING ORGANS. Silini, G. (C.S.N., Casaccia, Italy). pp 52-9 of Effects of Ionizing Radiations on the Haematopoietic Tissue. Vienna, International Atomic Energy Agency, 1967.
See STI/PUB-134.

Data concerned with the control of hematopoiesis and the action of radiation on the blood-forming organs are presented. It was obtained by the spleen colony techniques. The following points were investigated: pool of colony-forming (CF) cells in mouse liver fetuses at various times during intrauterine life; distribution of clone types from fetal liver or bone marrow cells; radiosensitivity of CF cells of fetal liver as compared to that of bone marrow CF cells; effect of differentiative capacity of CF cells on their radiosensitivity; RBF of fast neutrons and x rays for loss of reproductive integrity of bone marrow CF cells; and in vivo sensitization of bone marrow CF cells by use of DNA analogs. (B.S.L.)

49584 REVIEW OF RESEARCH PROJECTS ON QUALITATIVE AND QUANTITATIVE EFFECTS OF RADIATION ON HAEMATOPOIETIC TISSUE IN MAN AND EXPERIMENTAL ANIMAL. Hilberg, A. W. (Division of Radiological Health, Rockville, Md.). pp 45-51 of Effects of Ionizing Radiations on the Haematopoietic Tissue. Vienna, International Atomic Energy Agency, 1967.
See STI/PUB-134.

The research is organized into three major disciplines: epidemiology, radiation biology, and environmental sciences. Epidemiology is concerned with studies of populations and effects of radiation in man; radiation biology is concerned with effects in the experimental animal under controlled situations and also concerned with basic research in cellular and sub-cellular effects; and environmental science is concerned with transport mechanisms in the biosphere and how these mechanisms may operate and be interrupted to reduce radiation hazard to man. The ma-

jority of projects discussed are epidemiology studies of various population groups subjected, by chance, to varying exposures of ionizing radiation. (B.S.L.)

49585 RATES OF BLOOD FORMATION, AND OF BLOOD-CELL DEPLETION, AND RECOVERY AFTER IRRADIATION. Patt, H. M. (Univ. of California, San Francisco). pp 14-24 of Effects of Ionizing Radiations on the Haematopoietic Tissue. Vienna, International Atomic Energy Agency, 1967.

See STI/PUB-134.

Basic parameters of normal hematopoiesis that are pertinent to understanding radiation effects are examined. The radiosensitivity of blood cells as individual entities and as components of organized systems is then considered. The validity of models for compartmental analysis of blood cell balance is discussed. (26 references). (B.S.L.)

49586 SOME RECENT DATA CONCERNING MECHANISMS OF RADIOLEUKEMOGENESIS. Duplan, J. F. (Institut du Radium, Paris). pp 149-56 of Effects of Ionizing Radiations on the Haematopoietic Tissue. Vienna, International Atomic Energy Agency, 1967. (In French).

See STI/PUB-134.

The etiology and pathogenesis of radioinduced leukemia in mice are discussed. The role viruses play is included. (B.S.L.)

49587 OCULAR EFFECTS PRODUCED BY EXPERIMENTAL LASERS. I. Q-SWITCHED RUBY LASER. Campbell, Charles J. (Columbia Univ., N. Y.); Rittler, M. Catherine; Swope, C. Hermas; Koester, Charles J. Amer. J. Ophthamol., 66: 459-70(Sept. 1968).

The ocular effects of an experimental Q-switched ruby laser were explored. Little or no damage was caused to any structure other than the retina. At low-power values the retinal lesions appeared clinically similar to those produced by a conventional ruby laser, except that little fibrosis and pigmentation were found histologically several weeks after treatment. With higher-power values, the lesions were explosively hemorrhagic in character and resulted in total local retinal destruction. The ocular hazard of high powered Q-switched equipment was demonstrated. No clinical applications were found. (auth)

49588 SUMMATION OF CARCINOGENIC EFFECT OF 4-NITROQUINOLINE 1-OXIDE AND β RAYS. Hoshino, Hiroshi; Tanooka, Hiroshi; Fukuoka, Fumiko (National Cancer Center Research Inst., Tokyo). Gann, 59: 43-9(Feb. 1968).

Combined effects of two carcinogens, both in subthreshold doses, in ddN mice were studied. 4-Nitroquinoline-1-oxide was applied to skin in a 0.25% solution in benzene. β radiation was administered by a $^{90}Sr-^{90}Y$ source at a dose rate of 340 rad/min. Used alone, 20 applications of the compound or β-ray doses up to 3400 rad did not induce tumors over observation periods up to 450 days. When mice were treated with 20 applications of 4-nitroquinoline-1-oxide three times a week, followed by a 2-min β irradiation ten days later, two out of the 46 mice showed partial depilation but no acute skin damage. Three of the 46 mice developed papillomas by 40 to 60 days after irradiation. In a similar group of mice, 12 skin tumors were produced with β irradiation followed by 4-nitroquinoline-1-oxide treatment. In the experiments employing the reversed order of application, the reduced skin tumor production probably resulted from destruction of neoplastic cells induced by 4-nitroquinoline-1-oxide treatment by subsequent β irradiation. These findings support the hypothesis that carcinogenesis results from the summation of multiple carcinogenic effects in the cell subunits, even when these effects were caused partly by chemical and partly by physical agents. (BBB)

49589 AUTOIMMUNE HEMOLYTIC ANEMIA, ACUTE LEUKEMIA, AND CARCINOMA OF THE LUNG: SODIUM PHOSPHATE-^{32}P TREATMENT OF POLYCYTHEMIA VERA. Holland, Paul V.; Menken, Matthew; Berlin, Nathaniel I. (National Cancer Inst., Bethesda, Md.). Arch. Intern. Med., 120: 341-4(Sept. 1967).

A patient who initially had developed polycythemia vera was treated with sodium phosphate-^{32}P and subsequently developed acute myelogenous leukemia and adenocarcinoma of the lung, complicated by autoimmune hemolytic anemia. Treatment with ^{32}P was begun with a 3 mCi dose in May, 1963 and was followed over the next 22 months with four additional doses of 3 mCi each, for a total of 15 mCi of ^{32}P. Leukemia was diagnosed 26 months after the first dose of ^{32}P had been administered. The leukemia was unresponsive to massive combination chemotherapy, and the patient died. At postmortem examination, a tumor mass was discovered in the lung which microscopic examination showed to be a poorly differentiated adenocarcinoma involving perivascular and peribronchial lymphatics, blood vessels, and alveolar spaces. The bone marrow was diffusely infiltrated with leukemic cells. (BBB)

49590 INDUCTION OF LYMPHOMA AND LEUKEMIA BY DIAGNOSTIC AND THERAPEUTIC IRRADIATION. Latourette, Howard B. (Univ. of Iowa, Iowa City). Radiol. Clin. N. Amer., 6: 57-61(Apr. 1968).

Clinical, epidemiologic, and experimental data indicating a relationship between exposure to ionizing radiation and subsequent development of leukemia or lymphoma were reviewed. Epidemiologic evidence was the main basis for the conclusion that radiation had a leukemogenic effect. Relatively high doses of radiation were followed by a significant, predictable increase in the incidence of this relatively rare group of diseases. As the level of radiation exposure decreased, it was increasingly difficult to prove that there was a cause-and-effect relationship. The details of this cause-and-effect relationship, particularly at the lower radiation dosage levels, were still being established. (BBB) (TSS)

49591 CASE OF EXOSTOSES FOLLOWING X-RAY THERAPY. Poliakov, G. M. (Central Inst. of Traumatology and Orthopedics, Moscow). Ortop. Travmatol. Prot., 25: 56-7(Apr. 1964). (In Russian).

A 14-yr-old boy developed protruding bony growths on his right hand and forearm one to two yr after he had received two x-ray treatments for the removal of warts from his right hand. The first treatment, nine yr earlier, consisted of 1749 R in four exposures, the second one, seven yr earlier, 1288 R in three exposures. The total dose in the two treatments was 3037 R concentrated to a 1 × 1 cm focal area. In 1958, the first small outgrowth was noted on the distal part of the right radius, also another one on the proximal phalanx of the third finger, both on the right hand and forearm. Later, shortening of the right hand fingers was seen. Another bony outgrowth appeared on a finger, on the palm side of the same hand. These protuberances grew rapidly to cherry size and were covered with normal-appearing skin. X-ray examination showed a presence of ossified cartilaginous exostoses on the right hand and forearm. Neurological examination revealed atrophied intercarpal muscles, hyperesthesia of the median nerve in the radial region, and decreased excitability of the muscles of the same hand. Treatment consisted of surgical resection of the exostoses. (BBB)

49592 RISK OF THYROID CANCERS FOLLOWING IRRADIATION. Dolphin, G. W. (United Kingdom Atomic Energy Authority, Harwell, Eng.). Health Phys., 15: 219-28(Sept. 1968).

The data of Hempelmann et al. (J. Nat. Cancer Inst. 38: 317 (1967)) were analysed and a risk estimate for thyroid cancer of $100/10^6$/rad obtained for persons who received x irradiation to the thyroid as treatment for thymic enlargement in infancy. This value of risk is compared with the previous lower estimates. A review was also made of all the data available from which estimates of the risk of thyroid cancer can be calculated. The cancer risk following x irradiation in adult life appears to be lower than that following x irradiation in infancy. The finding of thyroid nodules in persons following intakes of radioiodine is discussed. It is noted that the life expectancy following diagnosis of thyroid cancer varies with the type of cancer and the age at diagnosis. Unlike most other cancers, the longest survival time appears to be for the youngest age groups. (auth) (UK)

49593 STUDY OF CARDIAC DYNAMICS IN HYPERTHYROID SUBJECTS AFTER TREATMENT WITH ^{131}I. NOTE II. Papalia, D.; Infantone, E.; Leonardi, V.; Bonaventura, S. (Univ., Catania, Italy). Minerva Med. Sicil., 13: 183-8(Apr.-June 1968). (In Italian).

The behavior of the systole phases of the ventricle after treatment with ^{131}I was studied in 12 hyperthyroid patients. On the basis of the data obtained it was concluded that treatment did not significantly affect the various phases of cardiac dynamics but did attenuate the sympathetic-tonic aspect of myocardial activity and helped to lighten the work the heart was called on to perform in this condition. (auth)

49594 EFFECT OF ULTRASONICS OF IODINE METABOLISM IN GUINEA PIGS. Slawinski, Piotr (Zaklad Chemii Fizjologicznej, Szczecin, Poland). Rocz. Pomor. Akad. Med. Szczecinie, 11: 259-82(1965). (In Polish).

The effect of high-frequency sonic irradiation on ^{131}I metabolism was reported, after a discussion of the effect of ultrasonic irradiation on natural chemical compounds and living organisms, and of present understanding of the mechanism of action of ultrasonic energy. Experiments were performed on 120 male guinea pigs, weighing 400 to 600 g, exposed one to 30 times to a frequency of 800 KHz at an intensity of 0.5 to 1 W/cm^2. Each exposure lasted 10 min. Subcutaneous injections of 10 μCi of ^{131}I were made in experimental and control animals. Accumulation of radioiodine in the thyroid, total radioiodine concentration in the blood, and the proteinbound ^{131}I level were determined. Radioactivity was measured in urine excreted within 24 hr after ^{131}I injection. Short term

ultraacoustic stimulation increased thyroid ^{131}I accumulation, increased the concentration of iodinated compounds in the blood, and decreased excretion of radioiodine in the urine. Prolonged ultrasonic irradiation decreased thyroid function. Animals with a marked thyroid hypofunction showed decreased diiodothyronine and triiodothyronine synthesis. It was concluded that ultrasound stimulated or depressed thyroid function according to dose applied. (49 references) (BBB)

49595 ELECTRON MICROSCOPIC STUDY OF RABBIT CILIARY BODY IRRADIATED WITH FAST NEUTRONS. **Mukai, Kenji (Hiroshima Univ.). Jap. J. Ophthalmol., 12: 1-11(Jan.-Mar. 1968).**

The eyes of 10-week-old albino rabbits were irradiated with 14.1-MeV neutrons from a T(d,n) reaction neutron generator, and light and electron microscopic observations were made of the ciliary body, especially the epithelial cells. The major ciliary body findings noted by light microscope were edema and hemorrhage into the stroma. These findings were marked chiefly among those observed up to the eighth day. Electron microscopy showed widening of the intercellular space of the base of the outer epithelial cell layer and ciliary channels. Also seen were lamellar bodies and inclusion bodies suggesting the presence of cytolysomes within the inner epithelial cells of two eyes 24 hr after irradiation with doses of 4.0 and 8.0×10^{10} n/cm^2. Another eye irradiated with a dose of 4.0×10^{10} n/cm^2 when observed four weeks later showed the presence of inclusion bodies, presumably cytolysomes, and destruction of the intracellular fine structure. Thus, degeneration of epithelial cells followed irradiation with fast neutrons. The lumen of ciliary body capillaries became enlarged and the walls became thin. The interstitial edema noted by light microscopy and the widening of intercellular space of the outer epithelial cell layer and capillary wall changes observed by electron microscope were considered to be related to the exudation of plasma protein components into the ciliary body. (BBB)

49596 PRENATAL AND EARLY POSTNATAL EXPOSURE TO ENVIRONMENTAL TOXICANTS. **Nair, V. (Chicago Medical School); DuBois, K. P. Chicago Med. Sch. Quart., 27: 75-89(Winter 1968).**

The effects of chemical and physical agents, especially ionizing radiation, on the development of the embryo and newborn are reviewed (104 references). Whether doses of radiation employed in normal diagnostic radiology were teratogenic and/or leukemogenic was not resolved. However, there were reports suggesting an association between abdominal radiography during pregnancy and the increased frequency of some cases of childhood leukemia. Epidemiologic studies revealed an association between diagnostic radiation in utero and an increased incidence of malignancies in children, not only of leukemia but also of tumors of neural origin and other neoplasms. Data from experiments using rats are included. (BBB) (TSS)

49597 PROTECTION FROM THE EFFECTS OF HIGH FREQUENCY ELECTROMAGNETIC RADIATION. **Pieslak, W. Ochr. Pr., 22: No. 8, 22-4(Aug. 1967). (In Polish).**

After briefly reviewing the damaging effects of exposure to high frequency electromagnetic radiation on the central nervous system, gonads, and lens, and the symptoms produced by such exposure (headache, dizziness, fatigue, nausea, and insomnia), data are presented, on threshold limit values of electrical field strength (in mW/cm^2) stipulated or recommended by authorities in the United States and in the Soviet Union. Suggestions for the guidance of designers responsible for providing shielding and other safety devices on apparatus giving rise to such hazards are included. (Occup. Safety and Health Abstr.) (CIS)

49598 CONTACT DERMATITIS. I. PHOTOCONTACT DERMATITIS FROM ANTIBACTERIAL AGENTS IN TOILET SOAP. **Hjorth, Niels (Finsen Inst., Copenhagen); Wilkinson, D. S. Brit. J. Dermatol., 80: 63-5(Jan. 1968).**

The sporadic occurrence of uv photodermatitis from halogenated salicylanilides, bithionol, and hexachlorophene in soaps and toilet preparations, and in some antifungal preparations is discussed. Photocontact dermatitis from tribromosalicylanilide (TBS) is elicited by long uv light with a maximum around 360 nm. Photopatch testing should be performed with uv light screened by window glass, Wood's light of high intensity, or by the use of black light fluorescent tubes. False-negative patch test reactions are apt to occur with a high-pressure mercury arc lamp without a glass screen, since the light emitted in the sunburn range limits the energy at 360 nm given to the patch tests. Natural sun may be used in appropriate climatic regions. Photosensitivity from halogenated salicylanilides depends on an allergic mechanism. The immunological mechanism in uv photocontact dermatitis is identical with that of simple contact dermatitis with the proviso that the haptene protein conjugate requires uv light energy for its formation. As in simple contact dermatitis, the spectrum of uv sensitivity is increased by testing with potential secondary photoallergens, a further indication that the mechanism is allergic. Many patients with uv photocontact dermatitis from TBS are sensitive to a large number of chemically related photoallergens. Although they avoid the allergen, ⅓ of patients also may have a persistent light sensitivity, that is apparently provoked by shortwave uv light. (BBB)

49599 PSEUDOSARCOMA, PSEUDOMALIGNANT NEOPLASM AS A CONSEQUENCE OF RADIODERMATITIS. **Samitz, M. H. (Univ. Hospital, Philadelphia). Arch. Dermatol., 96: 283-5(Sept. 1967).**

Following x irradiation 30 yr previously a woman with typical radiodermatitis developed a nodule on the left side of the tip of the chin. The lesion, present for one year, showed no recent change in size, and was completely asymptomatic. It was raised about 2 mm above the skin, was hard, and was unattached to the underlying bony structure. Clinically, it had the attributes of a calcified sebaceous cyst. The nodular thickening of the corium consisted of a loose textured collagenous matrix of moderate cellularity. The cells, that for the most part occurred individually rather than in groups or bundles, showed extreme variation in size and shape, the largest ones being quite bizarre. The nuclei were equally pleomorphic and often were only irregular chunky, dense, or pyknotic chromatin masses. Mitoses were very rare, if present at all. Vascularity was very meager. The epidermis was not neoplastic. Radiation fibromatoses fit into a category of fibroblastic growths in which the lesions are almost invariably benign and usually do not reappear after excision, but occasionally show persistent growth, and may precede the development of true fibrosarcoma. Fibroblastic tumors develop independently of other carcinomas or are the only type of lesion following irradiation of the skin. Histologic findings vary greatly from fairly orderly interlacing bundles of spindle-shaped cells of connective having moderately hyperchromatic lesions, bizarre mitotic figures, giant nuclei, and almost complete lack of collagen formation. (BBB)

49600 ESTROGEN SECRETION IN FEMALE ROENTGENOLOGISTS AND MEMBERS OF THE ROENTGEN LABORATORY STAFF. **Gelashvili, K. D. Med. Radiol., 13: No. 7, 3-8(July 1968). (In Russian).**

Estrogen secretion in women exposed to chronic effects of x radiation in low doses was studied dynamically. The irradiation dose did not exceed the maximal permissible level. An analysis of the results led to the conclusion that chronic external irradiation of the organism with low doses brings about inhibition of the estrogen formation, suppresses the development of the follicle, and defers the term of ovulation. (auth)

49601 THE EFFECT OF A SINGLE SUBERYTHEMIC BIODOSE OF ULTRAVIOLET RADIATION UPON THE STRENGTH OF COLLEGE WOMEN. **Rosentsweig, Joel (Texas Women's Coll., Denton). J. Ass. Phys. Ment. Rehabil., 21: 131-3(July-Aug. 1967).**

The literature indicated that uv irradiation had a favorable ergogenic effect, but the few investigations of this phenomenon reported in the literature considered only the effects of prolonged irradiation periods. The present study compared the relation of a single suberythemic uv biodose upon the strength of young women. Each of 23 subjects served as her own control in a double blind study. The uv or incandescent radiation was given on a rotation basis. The subjects received the radiation and the strength tests at the same time on two different days separated by a minimum of 48 hr. Sunlamps with a wave crest of 2967 Å and 200 watt incandescent light bulbs were utilized as sources of radiation. Six measures of strength were taken using a Narragansett Hand Synomometer to measure right and left hand grip strength and, with an attachment, pulling and pushing strength. A Nissen Dynomometer measured the leg and back strength. No significant change in strength was observed as a result of uv treatment. The trend of the data did indicate, however, a possible beneficial effect of uv light on strength. The optimal time for uv irradiation to act as an ergogenic aid was an individual phenomenon. It seemed that a longer period than one hr between treatment and test was necessary for the physiological benefits to accrue. Further experimentation should determine if there is a single optimal time for most individuals and if such a time holds true for all parameters studied. (BBB)

49602 COMMAND RADIATION GUIDANCE. **Linnemann, Roger E. (Univ. of Minnesota Hospitals, Minneapolis). Mil. Med., 133: 711-16(Sept. 1968).**

Cases of accidental exposure to whole-body irradiation were studied to correlate the biological effects of the radiation (course of radiation sickness) and the air exposure dose range. The staff surgeon's approach to evaluating the radiation health of a command and command radiation guidance, i.e., dose risk relationship for a

given operation established by a commander on the basis of a surgeon's advice, is discussed. It was concluded that the available data were not sufficient enough to warrant a sophisticated quantitative approach to fighting a radiation war. (B.S.L.)

49603 EFFECTS OF RADIATIONS ON MAN. III. THE CONSEQUENCES OF PRENATAL IRRADIATION. Leonard, A. (Centre d'Etude de l'Energie Nucleaire, Mol, Belg.). J. Belge Radiol., 51: 152-7(1968). (In French).

The radiosensitivity of mammalian embryos is closely related to the developmental stage. Irradiation during the preimplantation period causes a high incidence of prenatal mortality but very few abnormalities in the survivors. The period of major organogenesis gives a peak for gross abnormalities, and during the period of fetus development the sensitivity decreases to a low level. Clinical observations were performed on pregnant women irradiated for medical purposes. The higher incidence of leukemia among the children irradiated in utero was controversial, but the rate of malformations increased. Some chromosomal abnormalities appeared to be related to prenatal exposure to x irradiation. (auth)

49604 ADRENAL FUNCTION AT REMOTE PERIODS AFTER SINGLE AND FRACTIONAL IRRADIATION. Prokubina, E. A. (Central Scientific-Research Inst. of Roentgen-Radiology, Moscow). Med. Radiol., 13: No. 3, 12-15(1968). (In Russian).

The author compared the influence of single (800 R) and fractional (200 R four times with an interval of one week) irradiation on the adrenal function at remote periods after radiation. The function of the adrenals was assessed by the content of cholesterol in the adrenals of irradiated and nonirradiated mice. It is shown that the nature of changes occurring in different conditions of irradiation with a similar dose varies essentially. In single action there is a progressive decrease of the cholesterol content in the adrenals attended by an absence of reaction to ACTH. In fractional irradiation alteration of the adrenal function is of an irregular character and is less marked than in single action. The adrenals of mice subjected to fractional irradiation preserve their reserve possibilities manifesting a response to ACTH as in nonirradiated mice. On the basis of the data obtained the author supposes that fractional doses of irradiation are conducive to partial elimination of the radiation injury and change the nature of remote sequelae of irradiation. (auth)

49605 HANDBOOK OF DIAGNOSTIC CYTOLOGY. Hughes, H. E.; Dodds, T. C. Edinburgh and London, Livingstone Ltd., 1968. 265p. 100s.

A section is included on the effects of radiation on cells. (UK)

49606 TRACE CONDITIONING WITH X-RAYS AS AN AVERSE STIMULUS. Smith, James C.; Roll, David L. (Florida State Univ., Tallahassee). Psychonomic Sci., 9: 11-12(1967).

An aversion to saccharin flavored water (.1%) was conditioned in male albino rats using x rays as the noxious stimulus. The time interval between CS (saccharin) and US (x-ray) was varied for different groups and it was noted that an aversion could be formed when these stimuli were separated by as much as 12 h. Additional groups were run with 4% sucrose as the CS and the maximum effective time interval between CS and US was approximately 6 h. (auth)

49607 DEVELOPMENT OF WATER AND SACCHARIN PREFERENCES AFTER SIMULTANEOUS EXPOSURES TO SACCHARIN SOLUTION AND GAMMA RAYS. Smith, James C.; Schaeffer, Robert W. (Florida State Univ., Tallahassee). J. Comp. Physiol. Psychol., 63: 434-8(1967).

Using electronic drinkometer circuits, development of saccharin or water preference was studied in rats which had received saccharin solution, water, or an empty bottle simultaneously with 100 R of gamma irradiation from a ^{60}Co source (1.33 r/min). If the preference test was initiated immediately following exposure, all rats developed an aversion to saccharin within the 1st hour. If initiation of the preference test was delayed 24 hr., only rats which had saccharin presented during exposure developed the aversion. Sham-exposed rats showed characteristic preference for saccharin solution. Close temporal contiguity between saccharin ingestion and irradiation is a requisite for conditioned aversion to saccharin. (auth)

49608 ELECTROLYTE METABOLISM AND THE FUNCTIONAL STATE OF THE ADRENAL CORTEX IN ANIMALS AFFECTED WITH ^{210}Po. Moroz, B. B.; Grozdov, S. P.; Pinelis, V. G. (Inst. of Biophysics, Kiev). Med. Radiol., 13: No. 4, 63-9(1968). (In Russian).

Blood serum and tissue content of potassium and sodium, and the excretion of these electrolytes in urine of rabbits and rats after subcutaneous administration of ^{210}Po were determined. Simultaneously the functional state of the adrenal cortex was studied. It was found that in acute radiation sickness there develops hyperkaliemia and sodium retection in the organism. Hyperkaliemia was mainly due to potassium discharge from different tissues under the influence of radiation affection. A reduced sodium excretion and the effect of salt loadings testify to intensification of the mineral-corticoid function of the adrenal glands in acute radiation sickness. In subacute affection with polonium after the period of increased mineral-corticoid function there occurs a significant inhibition. These studies coincide with the results of histochemical and biochemical investigations of the adrenal function testifying to marked depletion of these glands at the late period of subacute radiation sickness. (auth)

49609 LICK RATES IN RATS EXPOSED TO GAMMA IRRADIATION. Schaeffer, Robert W.; Smith, James C. (Florida State Univ., Tallahassee). Psychonomic. Sci., 6: 201-2(Oct. 15, 1966).

Lick rates in male rats were measured before, during, and after irradiation with 100 R of γ rays. The Sprague–Dawley rats, about 120 days old at the beginning of the experiment, were irradiated in their home cages at a dose rate of 1.3 R/min. All rats were originally ad lib maintained on water for four weeks, then, 23-hr water deprived and presented with a 0.1% saccharin solution for 76 min daily for four consecutive days, with 23 hr intervening between each successive saccharin presentation. Procedurally, the first saccharin presentation constituted a sham exposure, and the third and fourth saccharin presentations were equivalent to the typical postirradiation saccharin preference tests described previously. Irradiation coincided with the second saccharin presentation. Momentary lick rates were determined for each throughout each of the four saccharin test periods. The mean lick rate and lick rate range obtained during irradiation and in the 2 postirradiation test periods did not differ from the rates that were recorded in the preirradiation test. Furthermore, neither the lick rate ranges nor the mean lick rates obtained in the present study differ from lick rates previously reported for nonirradiated rats tested under a variety of experimental conditions. These results were interpreted as further evidence that classically conditioned saccharin aversion is not attributable to prompt neutral alterations. (BBB)

49610 DYNAMICS OF CHANGES OF THE HYPOTHALAMIC NEUROSECRETORY SYSTEM IN TOTAL SINGLE GAMMA-IRRADIATION. Bibikova, A. F. Med. Radiol., 13: No. 4, 4-9(1968). (In Russian).

The paper contains data demonstrating that in single γ irradiation of dogs (^{60}Co—dose of 650 and 900 R) the activation of neurosecretion begins one day after the irradiation. Further changes depend on the dose value and the stage of acute radiation sickness. Inhibition of the neurosecretory process coincides, as a rule, with the peak of acute radiation sickness. (auth)

49611 THE HEMATOLOGY OF OCCUPATIONAL RADIATION INJURIES. I. FOLLICULAR AND SINUS LYMPHOCYTES. Zographov, D. G.; Gospodinowa, D. N. (Inst. of Radiology and Radiation Hygiene, Sofia). Deut. Gesundheitsw., 21: 826-9 (May 5, 1966). (In German).

Results are reported of hematological studies made on 200 individuals that ranged in age from 21 to over 60 yr; they were engaged in work as radiologists and laboratory and health care personnel in irradiation laboratories. These were compared with 25 persons from other types of laboratories. It was found that follicular lymphocyte counts decreased following a few years of service in laboratories where irradiation was used. This occurred much earlier than a decrease in the total numbers of lymphocytes or other signs of radiation-induced injuries of hematopoiesis. There was an additional decrease in follicular lymphocytes observed, along with decreased numbers of sinus lymphocytes, when the classical features of occupational irradiation hematopoietic injury became apparent. (BBB)

49612 REACTION OF THE CORTICAL LAYER OF THE ADRENALS TO TOTAL GAMMA-IRRADIATION. Molotkova, A. S. (Inst. of Medical Radiology, Erevan). Med. Radiol., 13: No. 4, 17-21(1968). (In Russian).

Rats of August line were subjected to total γ irradiation at a dose of 600 R. At 1½ hours after irradiation the adrenal cortex showed degenerative changes combined with death of cortical cells. At the end of one month there occurred no normalization of the histological picture. A study of lipids and cholesterol in the adrenals showed a parallel direction of changes in their content and revealed a definite phase-specificity in the reaction of the adrenal cortex to irradiation. The histologically-revealed degenerative changes of the adrenals were not the result of direct injurious action of radiation, but were the sequelae of hyperstimulation of the adrenal gland. (auth)

49613 REMOTE SEQUELAE OF RADIATION AFFECTION OF THE OVARIES. Gubareva, A. V. (Inst. of Roentgenology and Radiology, Moscow). Med. Radiol., 13: No. 4, 37-42(1968). (In Russian).

In the ovaries of mongrel albino mice subjected to γ irradiation at a dose of 200 R the changes that were in accordance with L. M. Shabad's scheme of blastomogenesis were observed. The first year after irradiation was characterized by the development of diffuse compensatory hyperplasia, against the background of which at the end of the first and beginning of the second year there was noted an occurrence of multiple nodose proliferates, from which developed the main number (61.3%) of tumors of the ovaries 12 to 18 months after irradiation. Hypoestrogenemia is castrated animals is the trigger mechanism of blastomogenesis. Normalization of the estrogen deficiency in irradiated animals prevented the development of ovarian tumors. The revealed neoplasms had the structure of the coma, granulose-cellular tumors, luteoma, sertolioma, cilioepithelial cystoma, and mixed variants. (auth)

49614 FUNCTIONAL STATE OF THE ADRENAL CORTEX IN PATIENTS WITH THYROTOXICOSIS AFTER RADIOTHERAPY. Gorbadei, N. K.; Bartova, V. F.; Kucherova, I. D.; Kozyrina, Z. N.; Parfent'eva, L. N. (Central Scientific-Research Inst. of Roentgen-Radiation, Moscow). Med. Radiol., 13: No. 4, 26-8 (1968). (In Russian).

Under study was the functional state of the adrenal cortex by means of dynamic determination of 17-ketosteroids in the urine in 105 patients with thyrotoxicosis in the process of radiotherapy. These studies established a definite regularity between the severity of the disease and the functional activity of the adrenal cortex, which usually normalized with improvement of the general state of patients under the influence of radiotherapy. (auth)

49615 RADIOIODINE ABSORPTION IN PATIENTS WITH POLYCYTHEMIA VERA AND ALTERATION OF THIS INDEX AFTER BLOOD LETTING AND RADIOPHOSPHORUS TREATMENT. Shishkina, V. V.; Suslina, N. G.; Chebotareva, E. D. (Kharkov Inst. of Medical Radiology). Med. Radiol., 13: No. 4, 50-4(1968). (In Russian).

The iodine-absorption capacity of the thyroid gland in 140 patients with polycythemia vera before and after blood letting and phosphorus-32 treatment was studied. Iodine-54 absorption in polycythemia vera in most cases (87.87%) is within normal values, however the dynamics of absorption is of a hypothyroid nature. Reduction of the thyroid function before treatment was found in 4.28%, increase—in 7.85% of cases. There was noted a relation between the iodine-absorption capacity of the thyroid gland and the severity of the disease and hematocrit index. Curative blood lettings resulted in a significant rise of the rate and percentage of radioiodine absorption. Successful radiophosphorus therapy also increased the iodine-absorption capacity of the thyroid gland in comparison with initial data. The thyroid gland in polycythemia vera became secondarily involved in the pathological process under the influence of changes of the general hemodynamics and oxygen starvation of tissues. (auth)

49616 LATE RESULTS OF BETATHERAPY IN THE TREATMENT OF CUTANEOUS ANGIOMAS. Peracchia, G.; Ugolotti, G. (Univ., Parma, Italy). Ateneo Parmense, Sez. I, Numero Speciale, 183-98(1967). (In Italian).

The occurrence of late complications of ^{90}Sr β radiotherapy in 39 patients with angiomas (cavernous type in 27 cases) was reported. Doses of 2500 to 15,000 rep were given, either in a single session or in fractions of 600 to 3000 rep in 7 to 40 days. The overall results were good in 79.5% of the cases, fair in 15.4%, and negative in 5.1%. The cavernous angiomas showed good results in 88.8% and more limited improvement in 11.1%. The results for simple angiomas were good in 58%, fair in 25%, and negative in 16%. The dose necessary to obtain good results was about 3000 rep although lower doses were effective in some cases. Analysis of the sequelae showed that achromia occurred in 77% of the cases, telangiectasia in 30.8%, atrophy in 74.4%, and pigmentation in 10.3%. The degree of untoward alterations was found to be closely related to the dose, in the sense that the achromia, atrophy, and telangiectasia were mild for doses up to 3000 rep, and progressively increased at higher doses. In general, invisible sequelae accounted for 46.2% and visible ones for 53.8%. (BBB)

49617 COMPARISON OF THE RESPONSE OF MAMMALIAN CELLS TO FAST NEUTRONS AND CHARGED PARTICLE BEAMS. Bewley, D. K. (Hammersmith Hospital, London). Radiat. Res., 34: 446-58(1968).

An attempt has been made to calculate the response of T1 kidney cells in tissue culture to four beams of fast neutrons, based on their response to charged particles using the track segment method. The calculated RBE's of the neutron beams are lower than the observed values, and the calculated values of the oxygen enhancement ratio are higher. These differences seem too great to be explained by errors in dosimetry and in the calculated LET spectra. It is suggested that LET is not an adequate criterion of radiation quality, and that the discrepancies may be explained by more detailed consideration of the part played by delta rays and by heavy recoil tracks of short range. The notion of a biologically effective LET is shown to depend as much on the nature of the biological test used as on the physical quality of the radiation beam. (auth)

49618 THYMUS CELL DEATH FOLLOWING IRRADIATION. Jackson, Kenneth L.; Christensen, Gerald M.; Forkey, Delores J. (Univ. of Washington, Seattle). Radiat. Res., 34: 366-77(1968).

Rat thymocytes were studied in vivo and in vitro following 1000 R of x irradiation to determine whether in vivo loss of nucleated cells is due primarily to mitotic inhibition or to interphase death. In vivo the rate of loss of live nucleated cells exceeded the rate of loss of total nucleated cells, and both rates exceeded that predicted on the basis of inhibition of cell division, implicating interphase death as a mechanism. Total thymus DNA decreased, but DNA associated with cell debris increased after irradiation, suggesting that cells killed by irradiation undergo lysis and that the resulting cell debris is removed more slowly than the cells break down. After in vitro irradiation thymocytes died in interphase at the same rate that live cells disappeared from the gland after in vivo exposure. It is concluded that the major mechanism for cell loss from rat thymus following whole-body exposure is radiation-induced interphase death followed by cell lysis. (auth)

49619 FRACTIONATED HEAVY ION IRRADIATION OF CULTURED HUMAN CELLS. Todd, Paul (Univ. of California, Berkeley). Radiat. Res., 34: 378-89(1968).

Cultured human kidney T1 cells were allowed to recover between paired doses of x rays and accelerated heavy ions. Recovery from sublethal doses of x rays and heavy ions having LET's up to 1650 MeV-cm^2/gm was evident on the basis of colony formation. No recovery could be detected between paired doses of accelerated ions having higher LET's, and very little between paired 150-rad doses of x rays. Survival curves for colony formation were also determined; recovery occurred whenever survival curves were "sigmoid" and was absent whenever survival curves were exponential. There was no obvious reduction in the extent of recovery at intermediate LET's, although it may have been slightly delayed. The results indicate that exponential survival curves correspond to irreversible inactivation and "sigmoid" survival curves correspond to lethality due to the accumulation of reversible sublethal lesions. The probability of the former appears to increase more rapidly with LET than that of the latter. (auth)

49620 ALTERED IN VIVO METABOLISM OF HISTIDINE (IMIDAZOLE-2-^{14}C) IN IRRADIATED RATS. Ngo, T.; Winchell, H. S.; Landaw, S. (Univ. of California, Berkeley). Radiat. Res., 34: 390-5(1968).

Irradiated rats (200 to 600 R) have an abnormal pattern of appearance of $^{14}CO_2$ in the breath following intravenous administration of L-histidine (imidazole-2-^{14}C) which is characterized by a prolongation of the time at which the maximum rate of $^{14}CO_2$ excretion occurs and a diminution in the total fraction of the administered ^{14}C appearing in the breath during the initial 80 minutes of the study. A possible explanation for these results is suggested to be the radiation inactivation of tetrahydrofolic acid or the processes responsible for its production. (auth)

49621 EARLY VASCULAR PERMEABILITY CHANGES IN WHOLE-BODY X-IRRADIATED RATS. Harris, John W.; Noonan, Thomas R. (Univ. of Rochester, N. Y.). Radiat. Res., 34: 357-65(1968).

The movement of ^{131}I-labeled homologous albumin from the vascular to the peritoneal compartment of rats during the hours following whole-body x-irradiation (750 R or 1500 R) is described. The concentration of labeled protein in peritoneal fluid after a short circulation time (30 minutes) increased rapidly following irradiation; this phenomenon did not reflect decreased peritoneal fluid volume or decreased peritoneal clearance of the labeled protein. The increase in relative peritoneal radioactivity was clearly biphasic after 750 R, with maxima of 62% and 79% above controls 4 to 8.5 hours and 48 hours after irradiation, respectively. After 1500 R, the effect was more sustained and reached a much higher level (230% above controls at 48 hours). The initial portion of the response was not dose-dependent, although the later phase was clearly so. (auth)

49622 IMAGINARY AND ACTUAL ENVIRONMENTAL LESIONS OF THE ORGAN OF VISION. Bider, E.; Rintelen, F. (Univ., Basel). Landarzt, 42: 1333-9(Oct. 31, 1966). (In German).

The possibilities that eye injuries may result from various types of irradiation are discussed briefly. The amounts of ir and uv irradiation emitted by television receivers will not cause any eye damage, and the amount of x rays emitted from a television receiver is far below the tolerance dose, amounting to at most 20% of the natural irradiation background. Direct, bright sunlight may damage the retina. Shortwave ir light may cause retinal edema, followed by scar formation, resulting in permanent retinal damage to central vision. Retinal detachments may be repaired by scar formation induced by thermocoagulation with an Xe lamp of 120,000 lumen. This type of light source is effective also for treatment of retinoblastomas in children or malignant melanomas in adults. A laser beam probably would be no more effective than a light coagulator of this type. Inflammation of the cornea and connective tissue and conjunctivitis may result from excessive exposure to uv light in the wavelength range of 220 to 300 mμ. Long-term exposure to longwave ir irradiation may produce injuries of the posterior portion of the lens. Doses of 600 to 1000 R of ionizing irradiation may produce lens opacity over a period of months or yr. Lens opacities have been observed frequently in cyclotron workers. (BBB)

49623 HYPOTHYROIDISM FOLLOWING TREATMENT OF THYROTOXICOSIS WITH RADIOIODINE. **Penington, J. S.; Martin, F. I. R. (Royal Melbourne Hospital). Med. J. Aust., 2: 641-3 (Sept. 30, 1967).**

The incidence of hypothyroidism following treatment of thyrotoxicosis with ^{131}I was 21% in a series of 155 patients followed from 8 to 15 yr. There was a lower incidence of hypothyroidism in those patients who received antithyroid drugs at about the time of therapy. The difficulties of assessment of these patients and the need for combined clinical and laboratory criteria for the diagnosis of hypothyroidism were stressed. No significant difference was found between the dose of ^{131}I given to those patients in the hypothyroid group (mean 8.5 mCi, range 4 to 23 mCi) and those who were euthyroid at the time of follow-up (mean 8.15 mCi, range 1 to 23 mCi). Forty-two of the patients had been treated with antithyroid drugs, either shortly before or after receiving ^{131}I. The incidence of hypothyroidism in this group was 12%, compared with 25% in the group not treated with antithyroid drugs. (BBB)

49624 EFFECTS OF X RAYS ON THE REGROWTH OF HAIR IN THE MOUSE AND THEIR MODIFICATION BY CYSTEAMINE. **Burlin, T. E.; Magnus, I. A.; Szur, L. (Inst. of Dermatology, London). Radiat. Res., 34: 287-99 (1968).**

The mouse hair follicle was used as a biological model for studying relatively long-term radiation effects and for evaluating radioprotective agents. The flank hair was plucked 3 days before irradiation, and four areas were given exposures of varying magnitude (500 to 5000 R). It was found that the delay in regrowth and the permanent damage (at 100 days postirradiation and later) increased with increasing exposure. The effect of cysteamine in protecting the hair follicle was to diminish the delay of regrowth and the degree of permanent epilation, though the general character of the response was unchanged. The dose-reduction factor appeared to diminish with increasing dose of radiation. A tentative explanation for this finding, based on the hypothesis of there being some hypoxic cells present, is suggested. The advantages of this type of nondestructive radiobiological model are discussed. (auth)

49625 OPHTHALMOPATHY OF GRAVES' DISEASE: A COMPARISON BETWEEN PATIENTS TREATED SURGICALLY AND PATIENTS TREATED WITH RADIOIODIDE. **Hamilton, Ronald D.; Mayberry, William E.; McConahey, William M.; Hanson, Kenneth C. (Mayo Graduate School of Medicine, Rochester, Minn.). Mayo Clin., Proc., 42: 812-18 (Dec. 1967).**

The incidence of post-treatment ophthalmopathy of Graves' disease was compared between a group of patients treated by subtotal thyroidectomy in 1946 and 1947 and another group treated with radioiodide in 1963 and 1964. Significant ophthalmopathy developed in 3.4% of the 177 patients treated by subtotal thyroidectomy and in 5.1% of the 98 patients treated with radioiodide; this difference was not statistically significant. An additional 27 patients with recurrent or persistent hyperthyroidism were treated with radioiodide; these patients did not have ophthalmopathy at the time of treatment. Twenty-two of these patients were followed and ophthalmopathy developed in 4.5%. This incidence was not significantly different from the incidence of ophthalmopathy after radioiodide therapy in patients without previous treatment. (BBB)

49626 LARGE DOSES OF RADIOIODIDE IN GRAVES' DISEASE: EFFECT ON OPHTHALMOPATHY AND LONG-ACTING THYROID STIMULATOR. **Pequegnat, E. Peter; Mayberry, William E.; McConahey, William M.; Wyse, Eduardo P. (Mayo Graduate School of Medicine, Rochester, Minn.). Mayo Clin., Proc., 42: 802-11 (Dec. 1967).**

During the treatment of severe ophthalmopathy in Graves' disease, an evaluation was made of the effect of larger-than-usual doses of radioiodide in 57 patients. Observations on the effect of this treatment on the ophthalmopathy and on the serum levels of long-acting thyroid stimulator (LATS) were reported. The dose of radioiodide was selected according to the size of the thyroid and the degree of thyroid uptake of radioiodide. The individual doses of radioiodide ranged from 20 to 100 mCi. The response to ^{131}I was most favorable in patients who had been treated previously with antithyroid drugs or by surgery. The response was least favorable in the group treated by radioiodide plus antithyroid drug or surgery; this group represents those patients with more resistant hyperthyroidism. The response to treatment seemed to be related to the severity of the ophthalmopathy at the time of treatment. Of the entire group of 57 patients, after treatment 40% were improved, 35% were unchanged, and 25% were worse. Attempts at correlation with thyroid uptake of tracer doses of radioiodide in the post-treatment period were inconclusive. It was concluded that the ophthalmopathy of Graves' disease is not readily altered by treatment with large doses of radioiodide. (BBB)

49627 CONTRIBUTION OF THE LYMPHOGRAPHIC EXAMINATION IN THE STUDY OF PATIENTS SUBMITTED TO SURGERY OR RADIATION TREATMENT FOR CANCER OF THE UTERINE CERVIX. **Corinaldesi, A.; Rimondi, C.; Bono, F.; Marani, A. (Univ., Bologna). Ateneo Parmense, Sez. I, Numero Speciale, 97-114 (1967). (In Italian).**

Postirradiation changes in the lymph glands and vessels were studied by inguinal, iliac, lumbar, and aortic lymphography. This study was of value in delineating sequelae of irradiation and differentiating them from cancer recurrences. Of the 45 patients studied 18 had undergone hysterectomy by the Wertheim operation, ten were hysterectomized and irradiated, and 17 received only radiotherapy. Implants of Ra and external telecobalt treatment were used to give doses of 400 to 4500 rad. Radiotherapy 30 days after hysterectomy did not produce any changes evident by lymphography, the only changes noted being attributed to surgery. After irradiation alone (higher Ra doses were used in this group), a characteristic reduction in the volume and number of lymphatic elements was seen and filling of the lymph vessels was irregular. (BBB)

49628 ADVANTAGES OF RADIOIODINE OVER THYROIDECTOMY IN TREATMENT OF GRAVES' DISEASE. **Crile, George Jr.; Skillern, Penn G. (Cleveland Clinic). Cleveland Clin. Quart., 35: 73-7 (Apr. 1968).**

Iodine-131 therapy was considered safer than thyroidectomy in hyperthyroidism. The possible and observed untoward effects of radioiodine therapy were discussed. It was assumed that in many cases it would be necessary to give four or more doses of ^{131}I of greater than 100 mCi. However, although hyperthyroidism in patients with large nodular goiters was often resistant to control with ^{131}I, the type associated with Graves' disease was controlled by a single dose of from 5 to 14 mCi. Of 3285 patients with Graves' disease treated with ^{131}I between 1947 and 1966, 63% were cured by a single treatment. Only two required doses in excess of 100 mCi. Although there was a high incidence of hypothyroidism after treatment with ^{131}I, it was suggested that the seriousness of this complication had been overemphasized. Ways to reduce the incidence of hypothyroidism after ^{131}I treatment were discussed. The incidence of hypothyroidism might be directly related to the dose of ^{131}I. Thus, by decreasing the amount of ^{131}I to one half of previous doses, and using iodide and antithyroid concomitantly, the immediate incidence of hypothyroidism after ^{131}I treatment was decreased. Whether ^{131}I caused cancer of the thyroid was considered. Several reports indicated that benign and malignant thyroid tumors followed radioactive iodine therapy for hyperthyroidism in childhood. Although a few benign nodules appeared in children, only two such nodules appeared in 256 adults treated by ^{131}I. No suppressive therapy was given routinely and no nodules appeared in children who were given enough ^{131}I to make them hypothyroid. No benign nodules or carcinomas were seen, one to 15 years later in a series of 40 children with Graves' disease treated with ^{131}I. In children, only two malignant tumors were reported after ^{131}I treatment. Radioiodine has not been reported to have caused cancers in adults. Although cancers of the thyroid were induced in rats by giving small doses of ^{131}I followed by thiouracil, the benign and malignant tumors that developed in rat thyroids after prolonged treatment with thiouracil did not develop when large doses of ^{131}I were given. If a cell could not divide, even when stimulated by thyroid-stimulating hormone (TSH), it could not

give rise to a mutant cancer cell. For this reason, large doses of ^{131}I, followed by life-long suppression of TSH by feeding of thyroid hormone, were safer than small doses given without suppression. (TSS) (BBB)

49629 AGE DEPENDENCE OF THE RADIATION SENSITIVITY OF WHITE RATS. II. DETERMINATION OF THE LD50(30) IN LATE FETUS AGES AND SHORTLY AFTER BIRTH. Reincke, Ursula; Rother, Mechthildis; Andris, Rainer (Univ., Freiburg i. B.). Strahlentherapie, 136: No. 1, 93-9(July 1968). (In German).

Gravid Wistar rats were x irradiated five or one day before the end of gestation. Newborn rats aged six hr were exposed in the same way; some of their mothers were also irradiated. A special experiment was performed to determine the absorbed dose in the fetuses and the newborns. The animals were studied during 30 days. Dose-effect curves were established for each age from the mortality data using probit-analysis. The LD-50 (30) value for fetuses five days prior to birth was 214 rads, one day prior to birth 273 rads, and for newborn rats 212 rads. The increase in radioresistance at the end of gestation is well-known. The reduction of LD-50 after birth is a new result. (auth)

49630 CHANGES IN THE NATURAL RADIATION RESISTANCE OF MICE AFTER SEVERAL-DAY STAY IN HYPOXIA. FUNCTION STATES AND RADIATION REACTIONS IN THE BLOOD-BUILDING TISSUE (PART I). Tribukait, Bernhard (Karolinska Institutet, Stockholm). Strahlentherapie, 136: No. 1, 100-12 (July 1968). (In German).

Investigations were made on the changes in γ radiosensitivity of mice following a 10 day stay in hypoxia. The changes in the count of granulocytes, lymphocytes, and thrombocytes in blood caused by hypoxia, as well as their reactions to irradiation with 400 R ^{60}Co γ rays 6, 24, 48, 72, and 96 hours after exposure to hypoxia were investigated during a period of 30 days. Hypoxia decreased the number of lymphocytes, granulocytes, and thrombocytes by about 50%. Depending on the type of cell, the cell concentration began to increase three to six days after hypoxia. Normal values were reached seven to 15 days after hypoxia. The radiation reaction was superimposed on the hypoxia reaction; the lymphocytes and, to a lesser extent, the thrombocytes of animals that were irradiated after hypoxia show a delayed recovery when compared with irradiated controls. A secondary decrease of the granulocytes that occurred about 10 days after irradiation of normal animals, and that was attributed to a failure of the bone marrow, could not be found in animals after hypoxia. Whether this was caused by a decreased radiation sensitivity of these cells, or was the result of improved survival chances of animals pretreated with hypoxia is discussed. (auth)

49631 COMPARISON OF SURVIVAL KINETICS AND MODIFICATIONS OF LETHAL DAMAGE IN CULTURED CHINESE HAMSTER CELLS EXPOSED TO SULFUR MUSTARD AND X RAYS. Mauro, F.; Elkind, M. M.; Sakamoto, K. (National Cancer Inst., Bethesda, Md.). Cancer Res., 28: 1143-9(June 1968).

The lethal properties of the bifunctional alkylating agent sulfur mustard are compared to x rays in cultured Chinese hamster cells. Survival curves and their dependence on pre- and post-treatment medium and temperature are presented. The results show that temperature and medium changes effected within 30 min after sulfur mustard treatment can bring about large shifts in the survival of surface-attached cells. In contrast, similar environmental changes produce only minor shifts in survival after x irradiation. These and other results to be reported suggest some qualitative differences in the actions of sulfur mustard and x rays. (auth)

49632 DIFFERENCES IN SURVIVAL VARIATIONS DURING THE GROWTH CYCLE OF CULTURED CHINESE HAMSTER CELLS TREATED WITH SULFUR MUSTARD AND X RAYS. Mauro, F.; Elkind, M. M. (National Cancer Inst., Bethesda, Md.). Cancer Res., 28: 1150-5(June 1968).

Although the survival of surface-attached Chinese hamster cells varies through the growth cycle after either x irradiation or sulfur mustard treatment, the variations differ. Cells in the latter part of the DNA synthetic phase yield maximum survival after x rays, while cells in the postsynthetic phase are the most resistant after sulfur mustard. As a result, when asynchronous cells are treated with either agent, they are rendered partially synchronized although out of phase. The differences in the cyclic variations of survival after treatment with sulfur mustard compared to x rays indicates that the damaging influences of these agents cannot be the same in all respects. (auth)

49633 COMPARISON OF REPAIR OF SUBLETHAL DAMAGE IN CULTURED CHINESE HAMSTER CELLS EXPOSED TO SULFUR MUSTARD AND X RAYS. Mauro, F.; Elkind, M. M. (National Cancer Inst., Bethesda, Md.). Cancer Res., 28: 1156-61(June 1968).

Survival curves of Chinese hamster cells exposed to graded doses of sulfur mustard are sigmoid; they start with a shoulder and become exponential. As in the case of x irradiation, this suggests that cells must accumulate damage for a lethal drug effect, and, therefore, survivors are initially damaged sublethally. In spite of the fact that the survival dependence on position in the growth cycle differs for sulfur mustard and x rays, in both cases surviving cells repair sublethal damage rapidly as they proceed to progress in their growth cycles. This is clear with asynchronous as well as synchronized cells. Further, as in the case of x irradiation, the repair of sublethal sulfur mustard damage can be demonstrated readily at a temperature (24°C) at which very little cell progression occurs. Although sulfur mustard may not be typical of cancer chemotherapy drugs, and cultured Chinese hamster cells may not be typical of cells of interest in man, these results demonstrate the possible importance of repair of damage when therapy involves fractionated drug treatments. (auth)

49634 EFFECT ON THE ONSET OF PUBERTY OF WHOLE BODY IRRADIATION OF INFANT FEMALE RATS WITH AND WITHOUT HYPOTHALAMIC LESIONS. Martinovitch, P. N.; Ivanisevic, O. K.; Martinovic, J. V. (Boris Kidrich Inst. of Nuclear Sciences, Belgrade). Experientia, 24: 839-40(Aug. 15, 1968).

At 8 days of age, female rats were exposed to 200, 400, or 500R whole-body x irradiation. Hypothalamic lesions were produced by microcoagulation at 20 and 25 days of age. The onset of puberty was determined by the opening of the vaginal orifice. Results suggested that lesions in the hypothalamus accelerated the onset of puberty in the irradiated rats as they did in non-irradiated animals; exposure to x rays delayed puberty in direct relation to dose whether or not lesions were present. (C.O.)

Radiation Effects on Plants

Refer also to abstracts 49187, 49188, 49267, 49282–49285, 49297, 49299–49308, 49316, 49320, 49321, 49355, 49388, 49459, and 49652.

49635 SENSITIZATION TO X-RAYS OF HYPOXIC VICIA FABA ROOT MERISTEMS BY INDANETRIONE. Foster, J. L. (Mount Vernon Hospital, Middlesex, Eng.). Int. J. Radiat. Biol., 13: 577-9(1968).

Roots of Vicia faba were x-irradiated under aerobic and hypoxic conditions. Indanetrione was applied to irradiated and unirradiated roots under both conditions. Results showed that roots were sensitized substantially by hypoxia, and that there was an additional sensitizing effect on roots treated with indanetrione. (H.L.W.)

49636 MUTAGEN SPECIFICITY IN PISUM SP. AND VICIA SATIVA L. Jaranowski, J.; Luczkiewicz, T. (Coll. of Agriculture, Poznan, Poland). Genet. Pol., 7: 115-23(Dec. 1966).

Dried seeds of Pisum and Vicia were treated with 1- to 50-KR doses of ^{60}Co γ rays and mutants sought in the developing plants. A progressive decrease in the rate of survival of plants with increasing doses of irradiation, similar to that observed earlier in Vicia faba and in Hordeum, was not seen. Rather, there were certain critical doses beyond which the drop in survival was sharp. In Pisum sp. an LD_{50} dose was found for certain genotypes at 50 KR, which was totally lethal for other genotypes, while in other lines it was 25 or even 12 KR. Plant injury was usually first seen as root necrosis. If the seedling was able to regenerate or develop adventitious rootlets (often just below the cotyledons), though with a great delay, it emerged. No necrosis was seen starting from the growing point of the stem. Degeneration appeared only as a consequence of root necrosis. Irradiation effects clearly occurred during the onset of growth and were directly proportionate to the dose. Doses of 1 KR stimulated the rate of germination and early development. Higher doses impeded these processes and the plants exhibited the characteristic symptoms as irradiation effects. At harvest, most lush plants with highest numbers of pods had received high doses of irradiation. However, the average number of seeds per pod was lowest in these groups. The specific response of the genotypes studied to irradiation as seen in the emergence capacity seemed to be a complex phenomenon, governed both by genetic factors and by somatic factors in the seeds. The lines of Pisum studied differed in the size of seeds, yet there was no correlation between radiation tolerance and the weight of the seeds. Analyses of the subsequent generations by cytological examination and genetic studies may explain this feature. The survival rate of first generation progeny was not equivalent to the mutation frequency rate. In the second

generation the spectrum of detectable mutations was slightly different. (BBB)

49637 CELLULAR SENESCENCE, RADIATION DAMAGE TO MITOCHONDRIA, AND THE COMPENSATORY RESPONSE IN RIPENING PEAR FRUITS. Romani, Roger J.; Yu, Ida K.; Ku, Lily L.; Fisher, Karl; Dehgan, Nancy (Univ. of California, Davis). Plant Physiol., 43: 1089-96(July 1968).

A compensatory response, viz., in vivo recovery from radiation damage to mitochondria, occurred in preclimacteric pear fruits (Pyrus communis L.) treated with 0.28 to 0.35 Mrad/hr γ radiation. The compensatory response was absent or markedly impaired in senescent fruits irradiated at or near the climacteric peak. Senescent cells failed to recover from harmful effects of radiation. Data are presented on mitochondrial yield, in vivo incorporation of amino acids into mitochondrial protein, and mitochondrial respiratory control and ADP/O. A diminished response to split-dose irradiation and a delayed rate of recovery confirmed the degeneracy and loss of compensatory power with cell age. A loss of restorative activity, especially in mitochondria that supply the cell with essential energy, may underlie the more obvious signs of cumulative stress that accompany cellular senescence. Use of ionizing radiation as an investigative tool and the molecular implications of radiation damage, recovery, and cellular senescence are discussed. (auth)

49638 IRRADIATION OF TOMATO POLLEN WITH ALPHA-PARTICLES. Scarascia Venezian, M. E. (Istituto Nazionale di Genetica per la Cerealicoltura, Rome). Genet. Agr., 21: 49-65 (Aug. 30, 1967). (In Italian).

The irradiation of mature pollen grains of tomato (cv. Battipaglia 0757) with ^{210}Po α particles causes a decrease in pollen germinability (LD_{50} = 12 kRad) and an inhibition of mitotis in the generative nucleus. On the basis of observations made on embryogenesis it can be concluded that: following treatment with 0.35 kRad, 25% of observed ovules showed a normal development of embryo and endosperm though delayed: after irradiation with 0.75 kRad the observed embryos stopped the development at the third division and the endosperm were abnormal; following 1.65 kRad treatment the embryo did not overcome the bicellular stage and after 3.3 kRad irradiation all observed ovules showed the embryonal sac empty demonstrating no fertilization by irradiated pollen. The treatment with doses higher than 2 kRad caused a decreasing fruit setting proportional to the employed dose. (auth)

49639 RECURRENT X-IRRADIATION IN DURUM WHEAT: INDUCTION OF VARIABILITY IN SOME MORPHOLOGICAL AND PHYSIOLOGICAL CHARACTERS. Bozzini, A. (CNEN, Rome); Fossati, A.; Scarascia Mugnozza, G. T. Genet. Agr., 21: 353-62(Nov. 30, 1967).

Analysis of a population of Cappelli durum wheat recurrently treated with 10 kR of x radiation and of a control population was made, taking into consideration the variability of some morphological and physiological parameters. In the treated population, there was an increase in the variability of all studied characters, except for the mean number of internodes of the main stem. The distribution of characters: heading date, length of main stem, number of fertile spikelets per spike, and mean tiller number per plant in the treated population presented asymmetry toward lateness, short straw, higher number of sterile spikelets, and lower number of tillers per plant. Only the total number of spikelets per spike showed an increase in variability that was clearly symmetrical. Data obtained from the analysis of the recurrently treated population were compared with data obtained analyzing a population given only one treatment. It could be concluded that, with the materials and methods used, there is no clear advantage in recurrent treatment to compensate for the noticeable increase in time and labor needed compared with a single treatment. (auth)

49640 INFLUENCE OF SEED WATER CONTENT ON THE OXYGEN EFFECT IN IRRADIATED BARLEY SEEDS. Conger, Bob Vernon. Pullman, Wash., Washington State Univ., 1967. 98p.

Thesis.

The interrelationship of radiation-induced free radicals and oxygen, as influenced by seed water content, as a mechanism in the production of biological damage caused by γ rays was investigated. Himalaya barley seeds were adjusted to various water contents ranging from about 1 to 14% by storage in vacuum desiccators over calcium oxide or different concentrations of glycerin water solutions. The seeds were irradiated with ^{60}Co γ rays in glass vials that were previously evacuated with a vacuum pump and sealed while still under vacuum. After irradiation the seeds were treated either aerobically by rehydration in oxygen-saturated water or anaerobically by rehydration in nitrogen-saturated water. Biological effects of the treatments were measured in terms of M_1 seedling injury and frequencies of chromosome aberrations and chlorophyll-deficient mutations. Increasing seed water content decreased the oxygen-enhancement ratios (for M_1 seedling injury) in a stepwise fashion. Furthermore, there were some regions of water content in which a small change greatly changed the oxygen response. A summary graph showing total influence of seed water content in the dry (1 to 14% water content) barley seed is presented. A remarkable decrease in oxygen-dependent damage during a post-radiation storage period ranging up to 4 weeks in a vacuum at room temperature occurred for seeds of about 10% water content. As the seed water content was decreased or increased from this level, this response became less. No storage response was found in dry (<6%) or moist (>12%) seeds for oxygen-dependent damage, nor for oxygen-independent damage regardless of the seed water content. The decrease in oxygen-dependent damage during post-irradiation storage in the seeds of about 10% water content was also accompanied by decrease in free radical signal as measured by electron paramagnetic resonance techniques. This relationship adds support to the hypothesis that free radicals and oxygen are related events in the production of radiobiological damage. Fractionated doses were not effective in reducing the oxygen-dependent or oxygen-independent damage. A close correlation was again noted between the oxygen-dependent damage and free radical signal in seeds of about 10% water content. An increase in oxygen-independent damage was noted for seeds given a fractionated dose or a total dose and stored for 10 weeks. (Disser. Abstr.)

49641 CHROMOSOMES AND CELLULAR RADIOSENSITIVITY. II. USE OF INTERRELATIONSHIPS AMONG CHROMOSOME VOLUME, NUCLEOTIDE CONTENT, AND D_0 OF 120 DIVERSE ORGANISMS IN PREDICTING RADIOSENSITIVITY. Underbrink, A. G.; Sparrow, A. H.; Pond, Virginia (Brookhaven National Lab., Upton, N. Y.). Radiat. Bot., 8: 205-38(June 1968). (BNL-11949).

Data regarding chromosome volumes nucleotide content per chromosome and concentration (nucleotides/μ^3) of chromosomal nucleic acid were compiled for 120 diverse organisms ranging from viruses to higher plants and animals. Interrelationships among these variables were studied both with respect to each other and to cellular radiosensitivity (D_0). It was found that the nucleotide content of most prokaryotes is linearly correlated with chromosome volume with a slope of +1. Another direct relationship also exists between these two variables among eukaryotes with a line of the same slope but with a different intercept. These correlations appear to hold over seven orders of magnitude. The nucleotide content of single-stranded viruses followed a line of shallow slope (< + 1) which intersected both of the direct progressions. When D_0 was plotted against chromosome volume on a log–log scale, the organisms formed eight regression groups (radiotaxa) whose slopes were −1. When, however, D_0 was plotted against total nucleotide content per chromosome the organisms with the exception of myxoviruses became aligned into four parallel regressions also having slopes of −1, but the groupings of organisms on these lines were not the same as those based on chromosome volume. Thus, depending on the parameter used, the same organisms formed a series of four or eight regressions. For either parameter, however, D_0 was inversely related to the parameter used. The groupings of organisms were mostly independent of their usual toxonomic classification ploidy level, or genetic complexity. The correlations between D_0 and chromosome volume may not be simply the direct proportionality between nucleotide content and chromosome volume, although in many cases, i.e. in plants, such a proportionality did exist. Concentration of chromosomal nucleic acid did not bear any obvious relationship to D_0. Compared to the ranges of the other variables, the range in concentration of nucleic acid in the chromosomes of many organisms was relatively small. The various interrelationships described may be useful in estimating cellular radiosensitivity. In terms of energy absorption at D_0, however, the regressions of D_0 against nucleotide content could be considered of little significance because energy must be absorbed within some critical volume and a volume calculated from numbers of nucleotides is thought to be highly artificial and, in most cases, unrealistic. It was concluded that the groupings of organisms based on interphase chromosome volume are probably more significant than those based on nucleotide content per chromosome. This is because the effective volume of the nucleic acid as far as ionizing radiation and energy absorption are concerned is probably its volume as it actually exists dispersed throughout the volume of the intact interphase chromosome. This effective volume appears to be adequately represented by the volume of the "interphase" chromosome. These nuclear parameters appear to be related to D_0 in such a way that, in general, a difference occurring in either chromosome volume or nucleic acid content should be expected to lead to a difference in radiosensitivity. (auth) (UK)

49642 IRRADIATION OF REGULARLY SPACED ROOT TIP CELLS OF VICIA FABA WITH 3-GeV PHOTONS. Staehler,

Fritz; Zywietz, Friedrich; Kuenkel, Hans A. (Univ., Hamburg). Strahlentherapie, 136: No. 1, 65-70(July 1968). (In German).

Meristem cells of root tips of Vicia faba were irradiated with doses up to 500 rad of 3 GeV bremsstrahlung. Dosimetry was carried out by means of the ferrous-ferric reaction. The root tips were fixed at various times after radiation. The rate of mitoses after 3 GeV radiation was compared with that after 200 kV x rays. A minimum of mitoses was found six hrs after doses up to 250 rad, with a maximum after 48 hours. Recovery from high-energy radiation was significantly greater than from conventional x rays. No recovery appeared after 50 rad of x rays. From dose-effect curves it was determined that RBE = 0.65. (auth)

Radiation Effects on Microorganisms

Refer also to abstracts 49185, 49223, 49224, 49231, 49235, 49237, 49266, 49268, 49279, 49284, 49287, 49295, 49296, 49325, 49435, 49455, 49457, 49461, 49462, 49548, 49641, 49660, and 49675.

49643 (COO-1645-2) MUTAGENESIS OF ENTEROVIRUSES BY GAMMA RAYS. Technical Progress Report, September 1, 1967-August 31, 1968. Cliver, Dean O. (Wisconsin Univ., Madison. Food Research Inst.). May 1, 1968. Contract AT-(11-1)-1645. 15p. Dep. CFSTI.

Human enteroviruses used were poliovirus type I, Coxsackie virus types A-9 and B-2, and Echo virus type 6. Virus suspensions were γ-irradiated using a ^{60}Co source, and virus tests and titrations were performed with primary rhesus monkey and swine kidney cell cultures. Radiation doses of 0.25 and 0.5 Mrad caused 36% and 99% inactivation, respectively, of poliovirus. Gamma rays were not very effective in causing mutations of poliovirus. Doses of 0.25 and 0.5 Mrad caused 80% and 95% inactivation of Coxsackie virus A-9. Tests indicated that the antibody-resistant fraction in this virus was greater by a factor of 10 than that in the unirradiated control suspension. Coxsackie virus B-2 irradiated with 0.25 and 0.5 Mrad doses showed no alterations in virulence markers; however, the irradiated virus reacted atypically in the diffusion-screening test. Radiation increased the relative efficiency of plaquing on swine kidney cell cultures. Irradiation of Echo virus type 6 did not cause a definitive change in the virulence markers; irradiated preparations gave heterologous reactions in diffusion-screening tests. With the exception of the poliovirus, each of the viruses showed some type of variation from the properties of its parent strain following irradiation. Apparent antigenic variants in three viruses and possible host-range alterations in one or two others were detected following treatment with γ rays. The findings evoked many questions concerning the nature of the variation and relationships of the derived strains to the parent strains of viruses. (H.L.W.)

49644 (NYO-3893-1) ULTRAVIOLET LIGHT EFFECTS ON NUCLEIC ACID FORMATION AND GENETIC EVENTS IN BACTERIA. Annual Progress Report, April 1968. Doudney, C. O. (Albert Einstein Medical Center, Philadelphia, Pa. Dept. of Genetics). Apr. 29, 1968. Contract AT(30-1)-3893. 13p. Dep. CFSTI.

Peroxide effects on survival and mutation induction were studied in bacteria exposed to uv and photoreversed. When uv-exposed Escherichia coli were incubated in the presence of hydrogen peroxide and yeast extract, a marked lethal effect was observed within 4 min. Results indicated that the interaction of the peroxides with some non-photoreversible uv damage causes considerable lethality but that this interaction has little effect in inducing certain reversions to phototrophy in auxotrophic bacteria. Mutation frequency decline and photoreversal of uv-induced mutation in mfd$^+$ and mfd$^-$ strains of E. coli were studied. It was found that photoreversal response of induced phototrophy corresponded to that of photoreversal of lethality in regard to amount of light exposure, suggesting that photoenzymatic elimination of pyrimidine dimers is responsible for both responses. The postirradiation time course of loss of the ability of photoreversing light to cause a reduction of mutation frequency of induced streptomycin resistance was followed. Results showed that loss of photoreversibility of induced mutation to streptomycin resistance occurred within the first 30 min of postirradiation incubation and before the initiation of postirradiation DNA replication. Studies on the effect of acriflavine on DNA and RNA formation in uv-damaged bacteria indicated the effects were related to the presence of the pyrimidine dimer; it is suggested that the dye acts by preventing the excision-repair mechanism. Studies were conducted on recovery of capacity for DNA and for RNA replication in uv-damaged bacteria. (H.L.W.)

49645 FILAMENTOUS SEX-SPECIFIC BACTERIOPHAGE OF E. COLI K12. III. UV, X-RAY, AND NITROUS ACID INACTIVATION OF BACTERIOPHAGE Ec9. Corno, C.; Dettori, R.; Neri, Maria Grazia; Zampieri, A. (Univ., Milan). G. Microbiol., 14: 217-25(1966).

Suspensions of phage Ec9 (2×10^7 PFU(plaque-forming units)/ml) and T6 (2×10^7 PFU/ml) were irradiated in 5 ml portions in uncovered Petri dishes with a G.E. germicidal lamp (15 W) at a distance of 52 cm from the sample. At different time intervals surviving phages were counted by plating the irradiated suspensions on E. coli K 12 W 1895 Hfr. Photoreactivation was obtained by exposing the incubated plates to a fluorescent lamp. X-ray inactivation was carried out at 60 kV and 1600 R/min. In both bacteriophage Ec9 and T6 uv inactivation followed first-order kinetics over three logarithmic cycles. The relative uv sensitivity of bacteriophage Ec9 compared with T6 was 0.183. Photoreactivation experiments on both uv-inactivated phage suspensions were reported. The photoreactivable sector calculated according to Dulbecco was 0.13 for bacteriophage Ec9 and 0.20 for T6. Some plaque mutants were obtained in the surviving fraction, and studies of a clear plaque mutant were being made. The results of x-ray inactivation experiments indicated one-hit kinetics. The x-ray inactivation curves of both bacteriophages were strictly exponential. The relative radiosensitivity of bacteriophage Ec9 versus T6 was 0.186, a value close to that (0.18) of bacteriophage ϕX174 versus T2. The lethal efficiency per ion pair produced in the nucleic acid expressed by the coefficient $e = 3.7 \times 10^{11}/DM$ where D is the dose (in roentgens) and M represents the nucleic acid content (in molecular weight units) was equal to 1 for bacteriophage Ec9 to 0.07 for bacteriophage T6. Both values were in agreement with those found earlier for single-stranded (0.64) and double-stranded (0.062) DNA bacteriophages. The high radiosensitivity of single-stranded DNA bacteriophages was confirmed. Nitrous acid inactivation of Ec9 and T6 demonstrated that Ec9 was more resistant than T6, the relative sensitivity being 0.17. (BBB)

49646 PRELIMINARY INVESTIGATIONS OF CHANGES IN STREPTOMYCES SP. 331-L ACTIVITY UNDER THE EFFECT OF GAMMA RAYS. Luba, Jerzy; Konar, Sulamita (Medical Academy, Warsaw). Acta Pol. Pharm., 24: 321-4(1967).

The effects of γ irradiation on erythromycin production by Streptomyces sp. 331-L was measured. After irradiation (^{60}Co), the spores were transferred to agar and incubated at 31 to 32°C for 20 days. Colonies formed from both irradiated and nonirradiated samples were transferred to agar slants that were incubated for 10 days at the same temperature. Antibiotic production was assayed by the biological (cylinder) method with Bacillus pumillus NC TC 8241 as the test species. Results showed that the mean activity of the populations obtained from the irradiated spores decreased parallel to the increase in radiation dose, from 12 to 60 kRad. The maximum production of antibiotic was obtained at 12 kRad. (TSS) (BBB)

49647 OBSERVATIONS ON INTERFERENCE INDUCED BY ULTRAVIOLET-EXPOSED REOVIRUS PARTICLES IN MONOLAYERS OF BSC-1 CELLS. McClain, Mary E. (California State Dept. of Public Health, Sacramento). pp 131-5 of Medical and Applied Virology. Sanders, Murray; Lennette, Edwin H. (eds.). St. Louis, Warren H. Green, Inc., 1968.

When infectivity of reovirus particles is reduced to survival levels of 10^{-2} to 10^{-3} by exposure to uv light, the phenomenon of multiplicity reactivation (MR) can be observed in FL human amnion cells both by immunofluorescent cell count (ICC) and by plaque assay. Similar evidence of MR was seen in ICC titrations of residual infectivity carried out in BSC-1, L929 and RK13 cells. However, plaque assay of uv-irradiated reovirus in these same cells resulted in various other effects ranging from MR in L929 cells, cytotoxicity in RK13, and interference in BSC-1 cells. The interference induced by uv-irradiated type 1 reovirus (Lang) in BSC-1 cells was examined in detail. No response to vesicular stomatitis virus (VSV) was seen in BSC-1 cells inoculated with 4×10^6 (originally infective) Lang uv-exposed particles, but viability of these cells, evaluated by morphology and neutral red uptake, was normal. Irradiation of BSC-1 monolayers with 450 erg/mm^2 of uv light prior to inoculation with uv-exposed type 1 reovirus particles suppressed the interference effect under examination. Although similar interference had not been observed in L929 cells, exposure of these cells to uv prior to inoculation revealed a striking effect on reovirus plaque development. In irradiated cells, appearance of plaques was accelerated by several days, size was increased by as much as 10 times and total numbers were 2 to 10 times greater than in normal cells. Results with actinomycin treatment and uv irradiation of host cells indicated that interferon may be involved in reovirus interference or produced during reovirus replication, particularly in L929 cells. (BBB)

49648 MECHANISM OF BACTERIAL KILLING BY RADIATION. Bhattacharjee, S. B.; Ganguli, Nati; Bhaumik, G. (Saha

Inst. of Nuclear Physics, Calcutta). Sci. Cult. (Calcutta), 34: 103(Mar. 1968).

Killing of bacteria, as defined by their inability to form visible colonies on agar plate, is the end point for the action of both x rays and uv rays. Though the intermediate steps in this process are not known, it is suggested that DNA, the genetic material, might be involved in the process. If both of these agents have a common site of action, it is reasonable to expect synergism between them. In order to study this, we chose a polyauxotrophic strain of bacterium E. coli 15, requiring the addition of thymine, arginine and uracil to the minimal medium for its growth. With this bacterium one has the advantage of selective inhibition of the DNA, protein and RNA synthesis by withdrawing thymine, arginine or uracil, respectively, from the growth medium, thus creating unbalanced growth. When these bacteria are incubated in minimal medium in absence of thymine, but supplemented with arginine and uracil, they undergo a killing process, known as thymineless death. In the present experiments, these bacteria were allowed to undergo different stages of unbalanced growth created by incubation in thymine-less medium. From each of these stages cells were collected for the determination of their sensitivity to x rays and uv rays. It was found that with the progressive increase in the thymine-less incubation there was a progressive increase in the sensitivity, reaching ultimately a maximum saturation value. It was also found that pre-irradiation with x rays or uv rays increased the susceptibility of the cells to thymine-less incubation. By pre-treating these cells with uv rays, their sensitivity to later x ray treatment could be increased to a saturation value. Also similar increase in uv-sensitivity was found for pre-x-irradiated cells. Thus a synergism between these killing agents was established. From the results of these experiments, it was concluded that all of these killing agents, at least in part, must act by influencing DNA inside the cell. (auth)

49649 SUSCEPTIBILITY OF HUMAN MYCOPLASMATA TO ULTRAVIOLET AND X IRRADIATIONS. **Furness, G.; Pipes, Florence J.; McMurtrey, M. J. (New Jersey Coll. of Medicine and Dentistry, Jersey City). J. Infect. Dis., 118: 1-6(Feb. 1968).**

A method is described for obtaining suspensions of elementary bodies of Mycoplasma pneumoniae that made it possible to demonstrate that human mycoplasmata are killed exponentially by uv and x irradiations. Previous reports indicated that mycoplasmata are resistant to uv light in colonies and susceptible in aerosols. The minimal reproductive unit or elementary body is a single cell 150 mμ in size, but colony-forming units in broth are usually clusters of elementary bodies. When elementary bodies of M. pneumoniae were irradiated, 99% were inactivated in 7.5 sec by uv light and by 30,000 R of x rays, respectively. The rates of inactivation were independent of concentration. Broth cultures of M. pneumoniae were not killed exponentially, confirming that they contain clusters of elementary bodies. Mycoplasma fermentans and M. orale were also susceptible to uv light. The technique for differentiating mycoplasmata from pseudocolonies by radiosensitivity is described. (BBB)

49650 OBSERVATIONS ON THE FERTILITY OF F^+ POPULATIONS IN E. COLI K12. INFLUENCE OF MITOMYCIN C, HNO_2, UV RAYS, HYDROXYLAMINE, AND CAFFEINE ON FERTILITY. **Rajchert-Trzpil, M.; Dobrzanski, W. T. (School of Medicine, Warsaw). Bull. Acad. Pol. Sci., Ser. Sci. Biol., 15: 465-71(1967).**

The influence of uv irradiation of 50 to 400 erg/mm^2 on the fertility of F^+ populations was studied. Mutagens with a relatively well-known mechanism of activity were used. The irradiation of F^+ donor cells resulted in a decrease in the yield of recombinations when the cells were crossed with the recipient immediately after exposure to uv. If, however, such an irradiated suspension of F^+ cells was incubated in broth before crossing, the fertility of the donor increased. In individual experiments, the yield of recombinants increased from 3 to 17 times. The peak of the increase in fertility of uv-irradiated F^+ cells was obtained after 45 min of incubation in broth at 37°. In the course of incubation in broth after uv treatment, the maximum yield of recombinants occurred when the number of cells that had survived exposure was not increasing yet or had just begun to increase. The E. coli K12 F^+ strain was irradiated with a uv dose of 250 erg/mm^2, which inactivated ~60% of the cells and increased the frequency of recombinants by up to about 20 times. It was possible to photo-reactivate up to 50% of the stimulating effect of uv rays on the yield of conjugation in the wild strain E. coli K12 F^+. (BBB)

49651 LEUKEMOGENESIS IN AkR MICE SUPERINFECTED IN ADULTHOOD WITH GROSS VIRUS (ABSENCE OF "SNEAKING THROUGH" IN A TOLERANT SYSTEM). **Latarjet, Raymond; Chamaillard, Liliane (Institut du Radium, Paris). Bull. Cancer, 53: 471-6(Oct.-Dec. 1966). (In French).**

The effect of ^{60}Co γ irradiation on the Gross leukemogenic virus in AkR mice was studied. Seven injections of a passage extract from AkR leukemic tissues were given at weekly intervals to AkR mice. The first injection was given at the age of 30 days. The extract was either active or inactivated by γ irradiation with 100 Krad. The irradiated extract did not modify the spontaneous leukemogenic process, but the active extract accelerated it. In neither group was the frequency of the leukemia decreased. The Eddy-Deichman effect, observed with SV-40 and adeno-12 viruses in hamsters, did not occur in AkR mice. These mice were tolerant to the leukemic cells transformed by the Gross virus. This result is consistent with the sneaking-through mechanism postulated for the Eddy-Deichman effect. (BBB)

49652 BIOSATELLITE II EXPERIMENT ENVIRONMENT. **Look, Bonne C. (Ames Research Center, Moffett Field, Calif.). BioScience, 18: 560-4(June 1968).**

Design of the payload of the Biosatellite II spacecraft planned to provide an automated lab suitable for radiobiological and other experiments in a weightless environment is described. The forward payload consisted of experiments exposed to an on-board radiation source. Experiment packages identical to those in the forward payload were located in the aft payload section to provide controls shielded from the radiation source. The radiation source (^{85}Sr) holder provided complete shielding of the source during launch preparation, launch, and recovery, and upon command, exposed the source to subject the experiments in the forward payload to the desired radiation dosage. At the end of the orbital flight period, prior to reentry, the source holder by command retracted the source to the fully shielded position. Lithium fluoride powder radiation dosimeters and thermistors were located inside or attached to the outside of each experiment package. A nuclear emulsion package measured the radiation entering the spacecraft from external sources, primarily protons and heavy particles. The on-board radiation source dosimeter measurements indicated that the doses delivered to the individual experiments were in agreement with the exposure time of 42 hr. Radiation exposures in the control area were low, varying from 1.22 to 0.60 R. (BBB)

49653 A CHARACTERIZATION OF A RECOMBINATION-DEFICIENT STRAIN OF SALMONELLA TYPHIMURIUM AND ITS INTERACTIONS WITH PHAGE P22. **Wing, Ofra Jennifer Patai. Ann Arbor, Mich., Univ. of Michigan, 1967. 143p.**

Thesis.

The recombination-deficient (Rec^-) strain, isolated following nitrosoguanidine mutagenesis, was first characterized by its high sensitivity to killing by ultraviolet irradiation and its greatly reduced ability to form recombinants in genetic crosses. The strain was also found to be highly susceptible to killing by streptonigrin and mitomycin C. During normal growth, the Rec^- strain degrades a large fraction of its DNA. The degradation is increased by ultraviolet irradiation of the cells. The Rec^- population contains a large fraction of cells which cannot divide but can support phage growth. This fraction may be responsible for the decreased growth rate observed in this strain. There are several abnormalities in the interaction of the Rec^- strain with phage P22. First, no transduction of any bacterial markers into the strain is found. Special efforts to detect transduction of the rec^+ gene (observed in E. coli Rec^- strains) were unsuccessful. Second, although phage P22 can lysogenize the Rec^- strain, the efficiency of integration is reduced and shows greater temperature sensitivity than phase integration into Rec^+ strains. Third, the Rec^- strain behaves like a heavily irradiated Rec^+ strain. This conclusion is based on the following findings: (1) infection of Rec^- cells with phage c^+ at high multiplicity results in a productive response with greater frequency than in a Rec^+ culture. (2) While prior irradiation of the Rec^+ strain favors the productive response, irradiation of Rec^- cells before infection does not further increase the extent of the productive response. (3) An unirradiated Rec^- strain shows the same (reduced) ability as an irradiated Rec^+ strain to host-cell reactivate irradiated phase. The above findings lead to the suggestion that in the process of repairing DNA breaks which occur during normal growth, a defect in the DNA repair mechanism of the Rec^- strain results in extensive DNA degradation in a fraction of the cells which can no longer form colonies. The formation of this fraction is responsible for the slower growth rate of the entire culture. In the majority of cells DNA repair is successful but the cells respond as if irradiated. Following ultraviolet irradiation, the inefficient DNA repair machinery cannot cope with the many lesions created and the vast majority of cells die. (Diss. Abstr.)

49654 RECENT BACTERIOLOGIC, IMMUNOLOGIC, AND PATHOLOGIC STUDIES ON EXPERIMENTAL HUMAN LEPROSY IN THE MOUSE FOOT PAD. **Rees, R. J. W. (National Inst. for Medical Research, London). Int. J. Leprosy, 33: 646-55(1965).**

Studies on the bacteriologic, pathologic, and immunologic aspects of foot pad leprosy infection in mice are reported, including radiobiologic experiments. It was conclusively demonstrated that human leprosy can be transmitted to the mouse foot pad, within which limited multiplication of Mycobacterium leprae occurs. Multiplication of M. leprae is dependent on the size of the inoculum and is confined to the foot pad. Some factor is responsible for limiting the infection with respect both to site and multiplication of the bacilli. Whether or not the limiting factor has an immunologic basis was investigated by exposure of the mice to thymectomy and total-body irradiation, since these combined procedures have a powerful immunologic depressive effect in the homograft reaction and antibody production. The results showed that significantly greater multiplication of bacilli occurred in the animals exposed to thymectomy plus whole-body irradiation (900 R), and therefore a part of the limiting factor could be an immunologic one. This conclusion was strengthened by the observation that an infection with M. tuberculosis is also enhanced by thymectomy plus whole-body irradiation. These studies represent the first deliberate attempt to use thymectomy plus irradiation to depress the development of immunity in experimental infections with M. leprae and M. tuberculosis. (BBB)

49655 RADIATION ENHANCEMENT OF SV 40 TRANSFORMATION IN 3T3 AND HUMAN CELLS. Pollock, E. J. (National Center for Radiological Health, Rockville, Md.); Todaro, G. J. Nature (London), 219: 520-1(Aug. 3, 1968).

Studies are described concerning the direct effect of radiation on the susceptibility of individual cells to tumor viruses, using tissue cultures of the mouse fibroblast line 3T3 and human diploid skin fibroblasts. Transformation assays were made. Irradiation was with filtered 250 kvp X-rays, at a dose rate of 17 R/min. Irradiation of infected 3T3 resulted in an increase in the number of transformed colonies, and a linear relationship was obtained between the logarithm of transformation enhancement and radiation dose; over the range tested each 200 R increment doubled the enhancement. Similar results were obtained for SV 40 transformation of human diploid fibroblast strains. Irradiation of the virus itself up to 2000 R had no detectable effect on its transforming capacity with either 3T3 or human cells. Thus it appears that radiation increases the probability that an oncogenic virus will produce tumors in animals. Depression of the immunological defenses plays a part in this process, but the studies described indicate a direct radiation effect on cellular susceptibility to transformation. (UK)

49656 EFFECT OF TEMPERATURE ON THE PHOTOBIOLOGY AND PHOTOCHEMISTRY OF BACTERIAL SPORES. Donnellan, J. E.; Hosszu, J. L.; Rahn, R. O.; Stafford, R. S. (Oak Ridge National Lab., Tenn.). Nature (London), 219: 964-5(Aug. 31, 1968).

Studies are described which indicate that the pronounced dependence of UV sensitivity of B. megaterium spores on temperature is largely interpretable in terms of the temperature dependence of the production of thymine-containing spore photoproducts. The yields of photoproducts showed a similar temperature variation to that of spore survival levels, suggesting that these photoproducts are involved in lethality. Interpretations are offered in terms of DNA and its environment. (UK)

49657 TOXICITY OF PASTEURELLA TULARENSIS KILLED BY IONIZING RADIATION. Landay, Marshall E.; Wright, George G.; Pulliam, James D.; Finegold, Milton J. (Medical Sciences Lab., Frederick, Md.). J. Bacteriol., 96: 804-10(Sept. 1968).

Approximately 2×10^{11} viable Pasteurella tularensis cells per ml, contained in suspensions, were killed by exposure to 10^6 R of γ-radiation. When injected intraperitoneally into mice, the irradiated suspensions initially contained about 10 LD_{50} per ml, and immunized mice against challenge with fully virulent strains of P. tularensis. Toxicity and immunizing activity of the suspensions decreased significantly within a few days at 5°C. Mice were protected against the toxin by immune serum or by prior injection of endotoxin of Escherichia coli. Cortisone did not protect against the newly prepared suspension, but was effective against the aged suspension. Lethal doses of newly prepared suspension for guinea pigs and rabbits were approximately 0.5 ml and 2 ml, respectively. Cortisone protected rabbits, but not guinea pigs, against lethal challenge. Pyrogenic effects resembling those shown by endotoxin-containing suspensions were demonstrated in rabbits. The results suggested that two toxins are responsible for the toxicity of irradiated suspensions of P. tularensis: one labile and associated with the immunizing activity of the suspension, the other more stable and resembling classical endotoxin. (auth)

49658 STATE OF THE AUTOFLORA AND BACTERICIDITY OF THE SKIN IN PATIENTS SUBJECTED TO RADIOTHERAPY. Smirnova, O. V.; Selikhova, V. V. Med. Radiol., 13: No. 3, 61-3 (1968). (In Russian).

Under examination were 29 patients with milk-duct carcinoma before x ray therapy, during and 2 weeks thereafter. There was found an increase in the surface and deep flora of the skin in these patients in different regions of the body. The changes were most marked in the deep flora that was sharply augmented in all the regions. The skin bactericidity in respect to E. coli altered in insignificant quantities. In a number of patients the bactericidal index of the skin dropped down to 30 and even to 0 percent at some areas. In the flora of the oral cavity during irradiation some patients showed the presence of E. coli and parenteral bacillus. (auth)

49659 INDUCING SPORULATION IN DIFFERENT STRAINS OF ALTERNARIA SOLANI. II. EFFECT OF ULTRAVIOLET LIGHT. Singh, Brij Mohan (Punjab Agricultural Univ., Hissar, India). Mycopathol., Mycol. Appl., 32: 163-71(July 31, 1967).

Because of conflicting evidence on the role of uv irradiation in inducing sporulation, a study was made of its effect in inducing sporulation in three strains of A. solani. Ultraviolet light induced abundant sporulation in two out of three strains studied. Scraped cultures produced larger number of spores than unscraped ones. Ten-sec exposure was found optimum for maximum sporulation. The optimum temperature of incubation subsequent to irradiation was 20°C. Young cultures were more responsive to uv light than older ones. However, old cultures were more tolerant to a greater time of exposure than younger ones. Intense uv irradiation greatly reduced or even completely inhibited sporulation whereas low intensity uv light was less effective in inducing sporulation. More than one irradiation greatly enhanced sporulation, the maximum was reached with four irradiations. Spore length was considerably influenced by the age of the mycelium, temperature of incubation, and the intensity and number of irradiations. (BBB)

Radiosterilization and Radiopreservation

Refer also to abstract 48995.

49660 (COO-1183-26) GROWTH CHARACTERISTICS OF TYPE E CLOSTRIDIUM BOTULINUM IN THE TEMPERATURE RANGE 34 TO 50 F. Annual Report, May 1, 1967-January 31, 1968. (Continental Can Co., Inc., Chicago, Ill. Metal Div. Research and Development). Apr. 15, 1968. Contract AT(11-1)-1183. 44p. Dep. CFSTI.

The immunodiffusion technique was used to detect the presence of Clostridium botulinum type E toxin in incubated fish samples. Nine cultures associated with nonspecific toxicities were injected intraperitoneally into mice to determine their possible infectivity. The cultures represented four Proteus, one Providence subgroup B, two Aerobacter, and two Erysipelothrix insidiosa. All of the cultures produced infections as shown by the isolation of organisms from blood cultures. The cultural characteristics and physiological behavior of the isolates were indistinguishable from those of the cultures injected. Samples of fresh cod were inoculated with spores of the Beluga strain of Clostridium botulinum. The samples were irradiated with 0.1 and 0.2 Mrad doses and incubated at 50, 46, 42, and 38°F along with unirradiated control samples. Samples were examined for odor, total count, pH, and the presence of type E toxin at time periods corresponding to fractions and multiples of the maximum expected storage life. Estimates of the maximum storage life are designated as X. Unirradiated control samples failed to show detectable type E toxin up to a time period corresponding to 1.5 X. Some of the irradiated samples showed toxin at 0.75 X and X. Toxin production was correlated with temperature and size of inoculum. The effect of various medium formulations on the sporulation of Cl. botulinum type C was studied. Preheating reduced the viable count appreciably. Botulinum toxin from two type C strains failed to show activation with trypsin under conditions that activate type E toxin. Trypsin digestion reduced toxicity in one strain. Effects of various media on viable spore counts were studied. (H.L.W.)

49661 (CNEA-231) PRELIMINARY ECONOMIC STUDY OF THE INHIBITION OF POTATO SPROUTING BY GAMMA RADIATION. Papadopulos, Celso C. (Comision Nacional de Energia Atomica, Buenos Aires (Argentina)). 1968. 39p. (In Spanish). Dep.

The possibility of using commercially the γ-induced inhibition of potato sprouting was evaluated. The parameters that characterize the production and commercialization of potatoes in the country are summarized. Experimental data from domestic and foreign sources are compiled on the inhibition of sprouting by

irradiation. The economic convenience of the method is analyzed. The analysis is limited to the calculation of the unit costs of treatment and no estimation is made of the general consequences of the introduction of the treated product into any market. The evaluation showed that from an economic viewpoint, the process is not competitive with chemical inhibition methods. (tr-auth)

49662 (ORO-3097-17) EFFECTS OF LOW LEVEL IRRADIATION UPON THE PRESERVATION OF FOOD PRODUCTS. Progress Report. Dennison, R. A. (Florida Agricultural Experiment Station, Gainesville). Feb. 1, 1968. Contract AT(40-1)-3097. 6p. Dep. CFSTI.

The extent of severity of the irradiation-induced peel injury of citrus fruits increased with increasing radiation dose, storage temperature, and storage duration. In most cases, a pre-irradiation hot-water dip for five min at 127°F, reduced significantly the induced peel injury, especially when the irradiated fruits were stored at low temperatures for relatively short durations. Slight losses in reduced ascorbic acid content (5 to 15%) resulted when citrus fruits were irradiated with doses up to 160 Krad. No difference in reducing sugars, sucrose, and total sugars were found due to irradiation. Higher juice yield and viscosity were exhibited by the juice expressed from irradiated Duncan grapefruit. Volatile flavor compounds extracted from irradiated Valencia oranges indicated some quantitative but few qualitative differences. These changes were more pronounced from early-harvested than from late-harvested fruit. Polyphenol oxidase preparations from peaches irradiated with 300 Krad and stored for two to three weeks exhibited increased activity and greater stability. Irradiation and hot-water treatments resulted in softer peaches. Changes in sugars content in peaches were more pronounced due to storage temperature and storage duration rather than by irradiation. A combination of a hot-water dip and irradiation was effective in decay control. Better decay control was obtained when fruits were irradiated within a short interval following the hot-water dip. Similar results were obtained with oranges. Preliminary shipping studies with Valencia oranges indicated no differences in reduced ascorbic acid, soluble solids, titratable acidity, or the overall acceptance ratings of the expressed juice due to irradiation or the hot-water dip. The hot-water treatment significantly reduced the severity of peel injury present on the irradiated fruit. (auth)

49663 (ORO-3698-2) INOCULATED PACK STUDIES ON LOW DOSE IRRADIATED MARINE PRODUCTS: SHRIMP. Annual Progress Report. Ward, B. Q. (Miami Univ., Fla. Inst. of Marine Science). May 1, 1968. Contract AT(40-1)-3698. 13p. Dep. CFSTI.

Sediment samples were examined for the presence of Vibrio parahemolyticus, a food-borne pathogen. A number of isolates exhibiting cultural similarities to the Japanese strains were found to be reactive with antisera prepared against Japanese strains, but reaction patterns were not consistent with the scheme used for typing in Japan. The large number of isolates recovered from sediments previously known to harbor Clostridium botulinum might indicate a common source of these two contaminants. Results of studies on shrimp from the Florida Keys are presented. Canned irradiated shrimp held at different temperatures were examined for toxicity to mice and plate counts. A table is included to show radiation dose, temperature, plate count of Clostridium botulinum, and mouse deaths. (H.L.W.)

49664 GUIDE TO SERVICES AND SUPPLIERS. FOOD IRRADIATION. Washington, D. C., Business and Defense Services Administration, 1967. 17p.

To assist in the application of food irradiation technology to commercial purposes, a directory is provided of companies and their officers that are active in this area. Included are lists of presently operating facilities, those under construction or planning, engineering and construction firms, design and fabrication firms, radioisotope suppliers and encapsulators, electron machine manufacturers, and government research facilities participating in this program. (C.O.)

49665 ADHERENT PROTEIN AND INTERSTITIAL PROTEIN OF WHEAT FLOUR IRRADIATED BY GAMMA RAYS. Deschreider, A. R. (Ministere des Affaires Economiques, Brussels). Ind. Aliment. Agr. (Paris), 83: 1589-94 (Dec. 1966). (In French).

Commercial wheat flour with 15.4% moisture was irradiated with 0.15, 0.5, 1.2, and 4 Mrad doses of ^{60}Co γ rays. Effects of irradiation on the separation of the adhering protein and the interstitial protein, their progressive extraction, physicochemical properties, and their elution in column chromatography were studied. Irradiating the flour facilitated the extraction of the interstitial protein, the optimum effectiveness being at doses of 0.5 Mrad. When the dose of radiation was not above 0.15 Mrad, a favorable influence was observed on this protein. This influence correlated with appearance of a maximum in the Hagberg number and in the solubility of the proteins of the gliadin type, as well as by the increase of the Pelshenke number. The improvement of the baking properties of wheat flours that have been noted for radiation doses between 0.02 Mrad and 0.15 Mrad could be explained by these changes. The effect of doses of up to 4 Mrad depended on the nature of the protein. Such high doses increased the amount of anionic proteins in aqueous and 40% propyl alcohol extracts. (BBB)

49666 STUDIES ON THE MICROORGANISMS OF CEREAL GRAIN. PART IX. γ-IRRADIATION EFFECT ON MICROFLORA OF RICE. Iizuka, Hiroshi; Ito, Hitoshi (Tokyo Univ.). Nippon Nogeikagaku kaishi, 41: 578-84(Nov. 1967). (In Japanese).

Unpolished and polished rices harvested in Japan, and polished rice imported from Spain were used. The following results were obtained: Chromogenic Pseudomonas and fluorescent Pseudomonas were found to be the main microflora of unirradiated Japanese rice, either unpolished or polished. Twenty to thirty per cent of microorganisms on Spanish rice were found to be molds. It was found that the main microorganisms of rice, including molds such as Penicillium and Aspergillus, which are the main microorganisms causing damage to rice, could be sterilized with a dose of 0.2 to 0.3 MR. When rices were irradiated at a dose of 0.2 to 1.2 MR, only red Pseudomonas survived. It should be noted that radioresistant yeasts were isolated from unpolished rice irradiated at a dose of 1 MR or more. No increase in the number of microorganisms was observed on the irradiated rice packed in a polyethylene pouch after 30 days storage at 10 and 30°C. (auth)

49667 CLOSTRIDIUM BOTULINUM TYPE E IN GULF COAST SHRIMP AND SHUCKED OYSTERS, AND TOXIN PRODUCTION AS AFFECTED BY IRRADIATION DOSAGE, TEMPERATURE, STORAGE TIME, AND MIXED SPORE CONCENTRATIONS. Jimes, Selvestion. Baton Rouge, La., Louisiana State Univ., 1967. 69p.

Thesis.

Investigation was done on the isolation and identification of C. botulinum type E toxin from Gulf Coast shrimp and oysters obtained from commercial processors and retail outlets. The capability of irradiated and nonirradiated fresh headless Gulf shrimp and shucked oysters to support the growth of C. botulinum and type E toxin production, as affected by various low doses of gamma irradiation, temperature, storage time and the size of a mixed spore concentration was studied. The results emphasized the importance of holding shellfish on ice at a temperature of 35°F rather than at refrigerated temperatures around 40°F in order to assure maximum consumer safety. The examination of more than 700 lbs of fresh Gulf Coast shrimp and more than 300 lbs of fresh shucked oysters for the presence of C. botulinum type E indicated its absence. Toxicity studies showed that no toxin was produced when fresh Gulf Coast headless shrimp and shucked oysters were stored on ice (33°F) up to 30 days, after being inoculated with mixed C. botulinum type E spores at 10^3 and 10^4 spores/g either without irradiation or with exposure to ^{60}Co radiation at 150, 200, 300, and 500 Krads. Fresh Gulf Coast headless shrimp were inoculated with mixed C. botulinum type E spores at 10^3 and 10^4 spores/g. Samples were subjected to ^{60}Co radiation at 150, 200, 300, and 500 Krads. The irradiated samples along with nonirradiated controls were then stored at 42°F. After 7 and 14 days, toxin was found in all samples except those that had received 500 Krads; in these, toxin was demonstrated after 30 and 31 days. Toxin production again was shown after 30 days when fresh shucked oysters were stored at 42°F after being inoculated with mixed C. botulinum type E spores/g and subjected to ^{60}Co radiation at 150, 200, 300, and 500 Krads along with a nonirradiated control. (Diss. Abstr.)(TSS)

49668 IRRADIATION OF PACIFIC COAST FISH AND SHELLFISH. 5. THE EFFECT OF 5'-INOSINEMONOPHOSPHATE ON THE FLAVOR OF IRRADIATED FISH FILLETS. Spinelli, John; Miyauchi, David (Bureau of Commercial Fisheries Technological Lab., Seattle). Food Technol., 22: 123-5 (June 1968).

Whether the presence or absence of 5-inosinemonophosphate (IMP) is related to the flavor attributes of irradiated fish was determined in two experiments. The threshold level of IMP was determined in two species of irradiated fish, and taste tests were carried out to determine whether irradiated and stored fish containing IMP was preferred to irradiated fish containing no IMP. Fillets of petrale sole and Pacific ocean perch were vacuum packed in enameled cans, γ irradiated and then stored at 33 to 35°F for at least 14 days to allow for complete degradation of IMP. Analyses of the fillets showed that degradation of IMP occurs between five and 12 days. The flavor threshold of IMP in fish is near 0.70 μM/g. When 1 μM/g of IMP was added to stored irradiated fillets containing no IMP, they were preferred to fillets that did

not contain IMP. It was concluded that IMP can be detected in small concentrations and that it imparts desirable flavor to fish tissue, leaving little doubt that IMP is associated with the flavor characteristics of fish. (BBB)

49669 PRESERVATION OF FOODS BY IONIZING RADIATION. Teixeira, Artur Ricardo Nascimento. Agricultura (Lisbon), 25: 9-13(Jan.-Mar. 1965). (In Portuguese).

Ionizing radiation methods for food preservation are briefly contrasted with classical methods. General considerations of the interaction of ionizing radiation with matter are reviewed. Interactions of x rays, γ rays, cathode rays, β rays, protons, neutrons, deuterons, and α particles are discussed. Particular emphasis is given to the interaction of accelerated electrons, with details of sources such as the Van de Graaff generator. The production of x and γ rays is reviewed; operation of ^{60}Co and ^{137}Cs sources is described; and the advantages of each type (^{137}Cs long half life, requiring fewer substitutions; ^{60}Co requiring a smaller number of units to achieve the same intensity of irradiation). Units of radiation and dosimetry are introduced. The mode of interaction of radiation on food products is broken into direct action on microorganisms and indirect chemical action. (BBB)

49670 COMMERCIAL PROSPECTS FOR SELECTED IRRADIATED FOODS. Yates, D. M.; Collings, G. W.; Kinne, I. L.; Kircher, J. R.; Litchfield, J. H.; Wilhelmy, O. Jr. Isotop. Radiat. Technol., 6: 77-83(Fall 1968).

A brief summary is presented of a recent report on the commercial prospects of selected irradiated foods, based on studies done at Battelle Memorial Institute. The outlook for commercialization, at the time of this study, for radiation pasteurization of marine products and radiation improvement of dehydrated vegetables is good. Radiation-treated beef, pork, and poultry need further investigation. (147 references). (auth)

49671 THE EFFECT OF IONIZING RADIATION ON TYPHOID BACILLI O AND Vi ANTIGENS. Sedova, T. S. (Gamalei Inst. of Epidemiology and Microbiology, Moscow). Zh. Mikrobiol., Epidemiol. Immunobiol., 41: 10-14(Jan. 1964). (In Russian).

Because of the unsatisfactory results obtained in the sterilization of chemically treated vaccines, experiments were devised to study the radiosensitivity of the purified Salmonella O and Vi antigens adsorbed on aluminum hydroxide and to ascertain the possibility of using radiosterilization in the preparation of radiovaccines against intestinal infections. Mice were used for tests of irradiated and nonirradiated antigens; rabbits were used for the production of irradiated and nonirradiated antisera. Doses of 0.6, 1, 1.5, 2, and 3 MR of γ rays were used for irradiation of the bacilli to prepare antisera in rabbits. The results indicated that the O and the Vi antigens of typhoid bacilli are radioresistant and attempts at radiosterilization by doses of from 0.6 to 3 MR caused neither significant changes in the immunogenic and antigenic properties of both antigens nor increased toxicity. Irradiation (doses 1 to 3 MR) of the adsorbed chemical vaccine also failed to reduce its immunogenic properties. It was concluded that cold sterilization might be used in the preparation of chemical vaccines against intestinal infections. (BBB)

49672 BASIC PRINCIPLES OF MICROWAVES AND RECENT DEVELOPMENTS. Goldblith, Samuel A. (Massachusetts Inst. of Tech., Cambridge). Advan. Food Res., 15: 277-301(1966).

The effect of high-frequency electrical fields on biological systems is reviewed with emphasis on the use of r-f energy in food processing. The bibliography includes 112 references. The following topics are considered: the nature of r-f energy, how r-f energy heats foodstuffs, the power equation, penetration of microwaves, electrical power and thermal energy, dielectric loss factors, types of microwave process devices, efficiency of microwave absorption into foods, choice of frequency, and possible uses of r-f in food processing, such as improvement of storage quality of cottonseed, destruction of foot-and-mouth disease virus, dehydration of vegetables, destruction of insects in grain, production of mold-free bread, blanching of foods, defrosting of frozen foods, microwaves in freeze-drying, microwave cooking, microwaves for sterilization, use of r-f energy for baking and for processing potato chips. The development of continuous types of tunnels and wave guides has revived the interest of the food industry in using r-f energy for food processing. However, there is little knowledge on the basic dielectric properties of foodstuffs under a variety of conditions. Such data are necessary and relevant to the problem of judging the optimum frequency for various types of foodstuffs and for different processing operations. These data are necessary not only for indicating the limitations of microwaves but also for indicating other possible uses of this new method of processing. (BBB)

49673 GROWTH OF SALMONELLAE ON IRRADIATED AND NON-IRRADIATED SEAFOODS. Matches, Jack R.; Liston, J. (Univ. of Washington, Seattle). J. Food Sci., 33: 406-10(July-Aug. 1968).

Salmonella give grew competitively in crabmeat at 22°C but not at 11°, 8°, or 5°C. At 22°C the cells grew rapidly reaching high numbers in all samples, but decreased in numbers at all lower temperatures. On English sole tissue, S. heidelberg, S. typhimurium and S. derby all grew rapidly at temperatures as low as 8°C from inocula as low as 10^1 cells/g and even in the presence of 10 to 100-fold higher numbers of competing saprophytes. Gamma radiation at relatively low levels, by reducing the numbers of competitive saprophytes, enhanced the growth of salmonellae on fish fillets. No growth was obtained under any condition when the temperature was held below 6°C. (auth)

49674 UREASE ACTIVITY IN A BLACK SPRUCE HUMUS STERILIZED BY GAMMA RADIATION. Roberge, M. R.; Knowles, R. (Dept. of Forestry and Rural Development of Canada, Sillery, Quebec. McGill Univ., Ste. Anne de Bellevue, Quebec). Soil Sci. Soc. Amer., Proc., 32: 518-21(July-Aug. 1968).

The activity of urease was studied in a black spruce (Picea mariana (Mill.) BSP.) surface organic horizon from Baie-Comeau, Quebec. Samples were sterilized by ^{60}Co radiation, incubated with urea for eight hrs at 20C and analyzed for ammonia. Urease activity decreased with an increase in humus decomposition. Field fertilization with 450 kg urea-N/ha two yrs prior to humus sampling increased the urease activity by 40%. Laboratory preincubation of field-fertilized and unfertilized humus with 3,500 ppm of urea-N resulted in increased urease activity of 90%. Enzyme assays performed with 21,000 and 63,000 ppm of urea-N gave similar relative activities to those performed with 3,500 ppm. Some mineralization of N occurred during and following irradiation in the absence of any added substrate. A direct relationship was found between enzyme activity and total and ureolytic numbers of microorganisms. (auth)

49675 ESTIMATION OF RADIATION RESISTANCE VALUES OF MICROORGANISMS IN FOOD PRODUCTS. Anellis, Abe; Werkowski, Stanley (Army Natick Labs., Mass.). Appl. Microbiol., 16: 1300-8(Sept. 1968).

Several statistical methods, including the conventional technique of Schmidt and Nank, were evaluated for estimating radiation resistance values of various strains of Clostridium botulinum by the use of partial spoilage data from an inoculated ham pack study. Procedures based on quantal response were preferred. The tedious but rigorous probit maximum likelihood determination was used as a standard of comparison. Weibull's graphical treatment was the method of choice because it is simple to utilize, it is mathematically sound, and its LD_{50} values agreed closely with the reference standard. In addition, it offers a means for analyzing the type of microbial death kinetics that occur in the pack (exponential, normal, log normal, or mixed distributions), and it predicts the probability of microbial death with any radiation dose used, as well as the dose needed to destroy any given number of organisms, without the need to assume the death pattern of the partial spoilage data. The Weibull analysis indicated a normal type kinetics of death for C. botulinum spores in irradiated cured ham rather than an exponential order of death, as assumed by the Schmidt–Nank formula. The Weibull 12D equivalent of a radiation process, or the minimal radiation dose (MRD), for cured ham was consistently higher than both the experimental sterilizing dose (ESD) and the Schmidt–Nank average MRD. The latter calculation was lower than the ESD in three of the five instances examined, which seems unrealistic. The Spearman–Kärber estimate was favored as the arithmetic technique on the bases of ease of computation, close agreement with the reference method, and providing confidence limits for the LD_{50} values. (auth)

49676 TOXICOLOGICAL SAFETY OF IRRADIATED FOODS. Kraybill, H. F. (Food and Drug Administration, Washington, D. C.); Whitehair, L. A. Annu. Rev. Pharmacol., 7: 357-80 (1967).

Data pertaining to the safety and wholesomeness of irradiated foods are reviewed. Consideration is given to toxicological, nutritional, and microbiological safety. The effects of radiation on chemical composition and microbiological content and experiments involving acute and chronic toxicity are reported. Various applications of food irradiation and requirements for national and international health legislative control and methods for identification of irradiated food are discussed. (94 references) (M.M.B.)

49677 IRRADIATED FOOD: FDA BLOCKS AEC, ARMY REQUESTS FOR APPROVAL. Jamison, Andrew. Science, 161: 146-8(July 12, 1968).

The position of the Food and Drug Administration (FDA) on irradiated ham for human consumption is reviewed. It is pointed out that to date radiation-processed bacon, potatoes, and wheat flour have been approved by the FDA for human consumption. Feeding

studies conducted by the AEC and by the Army in animals to establish the wholesomeness of radiation-processed fruits, vegetables, and meats are discussed. (C.H.)

49678 NUCLEAR IRRADIATION OF FOODSTUFFS. Resolution No. 41. Vitalst. Zivilisationskr., 13: 118-19(June 1968).

Resolution No. 41 of the Scientific Council of the International Society for Research on Nutrition and Vital Substances (1967), concerning the nuclear irradiation of foodstuffs, is presented. The resolution stresses the need for efficient biological and medical evaluation of the effects of irradiated foodstuffs before adoption of this method of food preservation. It is pointed out that animal experiments are not always conclusive and should be applied to humans with caution. It is suggested that all irradiated foodstuffs released for human consumption should be labeled with the radiation dose, storage time, and guarantee that they have been processed according to international standards. (C.H.)

METALS, CERAMICS, AND OTHER MATERIALS

Metals and Alloys

Refer also to abstracts 48979 and 49780.

49679 (ORNL-4270(Vol.1)) BIBLIOGRAPHY OF THE TECHNICAL LITERATURE OF THE METALS AND CERAMICS DIVISION FOR THE PERIOD, 1948-JUNE 30, 1967. (Oak Ridge National Lab., Tenn.). Oct. 1968. Contract W-7405-eng-26. 268p. Dep. CFSTI.

A bibliography is presented that contains 1500 references to scientific and technical publications issued by the Metals and Ceramics Division of the Oak Ridge National Laboratory from 1948 through June 30, 1967. The bibliography covers open literature publications, reports, and special literature, e.g., theses, patents, and translations. Subject and personal author indexes are provided. The subject index follows closely the style and philosophy of the subject indexes in NSA. Theses completed for advanced degrees and patents issued to staff members are presented in separate lists. (R.C.K.)

49680 (USBM-RC-1347) QUARTERLY METALLURGICAL PROGRESS REPORT NO. 39, APRIL 1-JUNE 30, 1968. (Bureau of Mines, Albany, Oreg. Albany Metallurgy Research Center). Contract AT(11-1)-599. 62p. Dep. CFSTI.

Developments are reported for studies on the preparation and properties of high melting point carbides; UC-UN-UO in production of high temperature reactor fuels; preparation and properties of W-Re-Mo alloys; preparation of high purity V by electrorefining; and the preparation of high purity Cr by the molten salt electrolytic technique. (F.S.)

49681 BIBLIOGRAPHY OF REFRACTORY METALS. Syre, R. (comp.). AGARD Bibliography No. 5. Maidenhead, Eng., Technivision Services, 1968. 448p. 135s.

Metals covered are Nb, Ta, W, and Mo. (UK)

49682 LATEST RESULTS AND PRESENT STATE OF POWDER METALLURGY. PART II. CONSTRUCTION MATERIALS. Eisenkolb, Friedrich. Neue Huette, 13: No. 1, 39-45(Jan. 1968). (In German).

The bibliographic review of the latest developments in the field of powder metallurgy is concluded. The powder metallurgy preparation of construction materials of iron, copper, nickel and cobalt, low-melting heavy metals, light metals, high-melting metals, titanium, zirconium, hafnium, and metal carbides was discussed. 124 references. (J.S.R.)

Corrosion and Erosion

Refer also to abstract 50735.

49683 (CONF-671007-4) EFFECT OF SOME ENVIRONMENTAL CONDITIONS ON STRESS-CORROSION BEHAVIOR OF NICKEL-CHROMIUM-IRON ALLOYS IN PRESSURIZED WATER. Copson, H. R.; Economy, G. (International Nickel Co., Inc., Sterling Forest, N. Y. Paul D. Mercia Research Lab.). [1967]. 25p.

From International Nickel Company Power Conference, Lausanne, Switzerland.

Stress corrosion tests were run in pressurized water at 600°F using double U-bends and double bent beam specimens. The tests were conducted in autoclaves for up to 3000 hours. The composition of the gas phase above the water and the pH were controlled. The materials tested were commercial heats of INCONEL 600, INCONEL 625, INCOLOY 800, and stainless steel Types 304, 304L, and 347; INCONEL 600 weldments; and experimental laboratory compositions. Several heat treatments were included. No attack was observed in specimens stressed at 90% of the room temperature yield strength. No attack was observed when hydrogen constituted the gas phase. No attack was observed when crevices were absent. The combined action of a high stress, a high oxygen concentration, and a crevice did promote intergranular attack and cracking in the crevice area in all alloys tested. The severity of the attack increased with the oxygen concentration. Many specimens heated for 2 hours at 1250°F showed deeper attack than annealed specimens. However, solution heat treatment, low carbon content or the presence of carbide stabilizers did not eliminate the attack. The behavior of weld metal deposits was not significantly different from the base plate. Variations in composition within the normal range of Inconel 600 were unimportant. Differences in behavior among the several alloys tested were minor compared with the environmental effects. (auth)

49684 (KR-127) CORROSION OF CARBON STEEL. Hornsveld, E. M. (Reactor Centrum Nederland, Petten. Institutt for Atomenergi, Kjeller (Norway)). May 1968. 27p. Dep.

The corrosion of carbon steel in water at 250°C with small amounts of oxygen (ca. 0.1 ppM) has been studied in a boiling, out-of-pile loop made of carbon steel. In addition to the steel specimens activated iron was used in order to facilitate the investigation of corrosion product release and deposition. The corrosion rate of carbon steel in boiling high temperature water with about 0.1 ppM O_2 was 25 mg/dm²/month after 3000 hours exposure and decreased to 10 mg/dm²/month or less at 9000 hours. Slightly different start up conditions (mainly with respect to oxygen content) had a significant effect on the initial corrosion, but the corrosion rate at long exposure was little affected. The rate of release of corrosion products to the water was approximately 15 mg/dm²/month at 3000 hours and dropped to a low value at 9000 hours, approximately 5 mg/dm²/month. The corrosion of mild steel in flowing water with 0.1 ppM oxygen at 15 to 20°C was linear, with a rate of about 45 mg/dm²/month. Nearly all the corrosion products formed were released. The experiments with activated iron indicated that about 50% of the iron oxide produced by corrosive reactions remained on the metal. The other 50% was released to the water, but a part of it was deposited back on the steel surface. (auth)

49685 CORROSION RESISTANT BERYLLIUM BODIES AND METHOD FOR PRODUCING SAME. (to Brush Beryllium Co.). British Patent 1,125,443. Aug. 28, 1968. Priority date Sept. 8, 1964, United States.

A process for preparing a beryllium body resistant to corrosion by air, water, and salt spray is given. The beryllium body is connected as an anode in an anodizing bath at a temperature below 130°F and at a current density from 48 to 300 A/ft² of the body. The bath consists of an aqueous electrolyte containing at least 0.4% by weight of sodium chromate and an amount of chromic acid sufficient to adjust the pH of the bath to a value from 5.5 to 7.5. The bath is free of HCl and H_2SO_4. (J.C.W.)

49686 OXIDATION OF MOLYBDENUM, TUNGSTEN, AND RHENIUM POWDERS AT ROOM TEMPERATURE AND IN AIR OF DIFFERENT HUMIDITY. Friedrich, K. (Institut fuer Metallphysik und Reinstmetalle, Dresden). J. Less-Common Metals, 16: 147-56(Oct. 1968). (In German).

The absolute rates of oxidation of molybdenum, tungsten, and rhenium powders at 20°C in air of different humidity were investigated. In air saturated with water vapor the formation of hydrous molybdenum oxides follows a linear rate law. On equal conditions tungsten is oxidized initially according to a logarithmic rate law, followed by a linear rate law. For both metals the linear oxidation constant was determined to 0.27 g cm^{-2} d^{-1}. The oxide formed by tungsten corresponds to the formula $WO_3 \cdot 2H_2O$. In dry air the amount of oxygen at the surface of the three metals after an exposure of 70 days reaches a value which corresponds to 1 to 3 monoatomic layers only. (tr-auth)

49687 RADIOACTIVE METAL CORROSION EVALUATER AND METHODS THEREFOR. Berk, Sigmund (to Secretary of the Army). U. S. Patent 3,399,303. Aug. 27, 1968. Filed Mar. 4, 1965.

Processes are given for quantitatively determining corrosion of metal specimens by placing them close to a suitable radioactive source and comparing the backscattered radiation emitted from the specimen with a previously calibrated standard. (auth)

49688 COMPLEX COATING FOR PROTECTION OF MOLYBDENUM. Shlyakova, K. S. Ogneupory, No. 6, 53-4(June 1968). (In Russian).

The results of experimental studies on the protection of Mo with multilayer coatings ($MoSi_2$ + Al_2O_3) from high-temperature oxidation are reported. In the annealing process during 720 hrs at 1200°C, mullite was formed in the coating as a result of the interaction of silica and γ-Al_2O_3. The properties of the coating were improved. (tr-auth)

49689 OXIDATION OF REFRACTORY METALS AND ALLOYS IN THE PRESENCE OF Li_2O. Geschwind, Gary (Grumman Aircraft Engineering Corp., Bethpage, N. Y.). Scr. Met., 2: 519-24(Sept. 1968).

Weight-change measurements and differential thermal analysis techniques were used to study the retardation effects of LiO_2 on oxidation of Mo, Nb, Ta, and W metal powders. Theories are postulated to explain the kinetics involved. (P.G.C.)

49690 SOME EXPERIMENTS ON HIGH TEMPERATURE AQUEOUS CORROSION OF METALLIC URANIUM FUEL ELE-

MENTS WITH DEFECTED CLADDING. Cerrai, E.; Scaroni, A. (CISE, Milan). J. Nucl. Mater., 27: 264-74(Sept. 1968).

Results obtained during compatibility experiments between a metallic uranium fuel element tube, clad with Zircaloy-2, and a steam-water mixture are reported. Three fuel element specimens were provided with appropriate defects and placed into a loop able to produce such mixture, about 15% steam by weight, at 285°C and 71 atm. The temperature gradient peculiar to power generation from a nuclear fuel element was simulated by electric heating. Results of the experiments, and the related metallographic analyses are reported in detail, together with a brief description of the experimental apparatus. On the basis of results obtained and of a study on thermodynamics and kinetics of corrosion reactions, an interpretation of the phenomenon is offered. (auth)

49691 ARC EROSION TESTS ON DIFFERENTLY PRODUCED W–Cu–COMPOUNDS. Althaus, B.; Vinaricky, E. (DODUCO-KG, Pforzheim, Ger.). Metall, 22: 697-701(July 1968). (In German).

The metal loss of samples of variously prepared tungsten–copper compound materials in high current arcs is determined and related to the type of preparation. The material prepared by the impregnation method shows a lower consumption rate than material sintered with or without liquid phase. The composition of the compound material and the mean particle size of the tungsten powder has only a smaller effect. In addition to the erosion stability, mechanical properties such as volume impregnation degree, shrinkage, density, and hardness as well as the electrical conductivity were determined. The impregnated material also showed the most favorable values. (tr-auth)

Preparation and Fabrication

Refer also to abstracts 49007 and 50767.

49692 (CEND–3742-342) VANADIUM PURIFICATION. Quarterly Progress Report No. 7, April 1–June 30, 1968. Wang, C. T.; Barock, E. F.; La Vake, J. C.; Christopher, S. S. (Combustion Engineering, Inc., Windsor, Conn. Nuclear Power Dept.). Aug. 1968. Contract AT(30-1)-3742. 29p. Dep. CFSTI.

Production amounted to 22 pounds of 0.040-inch thick, high purity V-15Cr-5Ti alloy sheet. A heat-treating study was performed on the high purity sheet material to determine the recrystallization temperature and to compare the heat-treating response of this material to high interstitial material evaluated by Argonne National Laboratory. Based on this evaluation, the recrystallization temperature for the low interstitial material was determined to be 1050°C for a 1-hour anneal. Mechanical testing has started on the as-received and recrystallized material. (auth)

49693 (NP–17605) PRELIMINARY STUDY OF THE CO-EXTRUSION OF DISSIMILAR METALS. Whitfield, E. (National Engineering Lab., Glasgow (Scotland)). Jan. 1967. 30p. (NEL–265). Dep.

A preliminary investigation has been made to ascertain the factors which govern the extrusion of rod, tube, and can from combinations of dissimilar metals. The results obtained showed that the flow of metal during coextrusion was dependent on the relative extrudabilities, disposition and dimensions of the dissimilar metals in the original billet, and on the die geometry. The coextrusion of rod appeared to be limited to metals of fairly similar extrusion characteristics and the loss of useful product owing to dissimilar flow appeared to be less if the billet was made such that the material of higher strength was wholly enclosed by that of the lower strength. No metallurgical bonding was achieved under the conditions of test at room temperature. (auth)

49694 PROGRAMMED WELDING OF END PLUGS TO FUEL CANNING TUBES. Sovik, R. H. (Institutt for Atomenergi, Kjeller, Norway). pp 209-24 of Fabrication of Ceramic Type Power Reactor Fuel Elements. VIII Nuclear Congress, Rome, 19–20 June 1963. Roma, Comitato Nazionale Energia Nucleare, 1967.

See CONF-193-(Vol.1).

Equipment and procedures, used at Kjeller Norway, for arc welding end plugs to fuel cans of zirconium, Zircaloy-2, aluminum, or stainless steel by a program of established welding cycles are described. Welding cycles are controlled by a variable speed motor with auxilliary gears, control rheostat, a welding current programmed cam which controls rheostat positioning, magnetic clutch for connecting the cam to the motor, a timer for delayed engagement of the magnet clutch, switches and relays. Effect of tube and end plug composition and design of components to eliminate root defects and lack of penetration are discussed. (P.G.C.)

49695 PIPE JOINT. Froman, Karl Goran Ernst; Karker, Stig Rutger; Tarandi, Taivo (to Aktiebolaget Atomenergi). British Patent 1,126,711. Sept. 11, 1968. Priority date Dec. 15, 1964, Sweden.

A joint to connect two reactor tubes, one of which is adapted to be used at a relatively low temperature and the other at the temperature of superheated steam, each composed of material having a different coefficient of thermal expansion, as steel and Zircaloy 2, comprises a clamping ring of material having a coefficient of thermal expansion, as Inconel X-750, lying between the two. Wall thickness and configuration of the tubes are designed to withstand strains caused by changes in temperature and bring about effective sealing. (P.G.C.)

49696 METAL FORMING. Rawson, Douglas Frederick; Hardman, Ralph (to United Kingdom Atomic Energy Authority). British Patent 1,125,288. Aug. 28, 1968. Filed Aug. 6, 1965.

A method is given of shaping a metal tube subjected to radial compressive pressure so as to form the tube into contact with a mandrel finished to a high degree of accuracy with respect to its cross-sectional form and straightness. The tube is removable from the mandrel by creating a clearance between them by differing thermal expansion characteristics. (J.C.W.)

49697 RELIABLE, PRACTICAL, PROTECTIVE COATINGS FOR REFRACTORY METALS FORMED BY THE FUSION OF SILICON ALLOY SLURRIES. Priceman, S.; Sama, L. (Sylvania Electric Products Inc., Hicksville, N. Y.). Electrochem. Technol., 6: 315-26(Sept.-Oct. 1968).

The processes involved in the application and formation of fused silicide coatings for refractory metals are described. The coating is characterized in terms of its chemistry, crystal structure, and morphology and its protective properties are defined on the basis of a number of rigorous tests including high- and low-temperature cycling, slow thermal cycling, low pressure-high temperature exposures, and re-entry simulation tests. Applicability properties are demonstrated by wettability and flowability tests, by the coating and testing of lap joint specimens, and finally, by the coating of large, intricate hardware. (auth)

49698 VACUUM PACK AND SLURRY COATING PROCESSES FOR COATING SUPERALLOYS. Gadd, J. D.; Nejedlik, J. F.; Graham, L. D. (TRW Inc., Cleveland). Electrochem. Technol., 6: 307-15(Sept.-Oct. 1968).

The vacuum metal pack, vacuum slip pack, and slurry fusion processes developed for application of high-temperature protective coatings on conventional superalloys and TD-Nickel are described. The specific coating elements include aluminum, chromium, tungsten, molybdenum, and tantalum, which are applied separately or in combinations to provide protective layers. The parameters and coating formation mechanisms are discussed for each coating process. The protective capabilities of the different types of coatings are presented. (auth)

49699 COMMENTS ON THE PAPER "GRAIN GROWTH DURING SINTERING OF TUNGSTEN". Mistler, R. E. (Western Electric Co., Inc., Princeton, N. J.). J. Appl. Phys., 39: 4875 (Sept. 1968).

The equation for grain growth under ideal conditions is $G^A - G_i^A = G_0 t$, where G = final grain size, G_i = initial grain size, G_0 = rate constant, and t = time. Kothari (J. Appl. Phys., 38: 2395 (1967)) assumed G_i to be negligible, whereas it is not (3 μ compared with G = 11 μ). Kothari's data at 1450, 1500, 1600, and 1650°C are reanalyzed; the data at the three lower temperatures are best fit by a G^2 vs t relationship, while the 1650°C data give an exponent of 3. It is concluded that the initial grain size cannot be neglected in a grain growth analysis. (D.L.C.)

49700 EXPLOSION PLATING. Hornbogen, E. (Univ., Goettingen, Ger.); Keller, K. Chem.-Ing.-Tech., 40: 806-11 (Aug. 26, 1968). (In German).

Explosion plating renders possible the manufacture of unusual or new metallic compounds which, by virtue of the properties of one or the other of the components, were previously only incompletely accessible in other ways. The physical processes in explosion plating, the properties of the compounds thus manufactured as well as a number of applications and practical conclusions, are discussed. (auth)

49701 ELECTROREFINED METALS AND ULTRAPURE METALS. Echeverria, Gabriel Arregui. Met. Elec. (Madrid), 31: 190-1; 193-5; 199(Jan. 1967). (In Spanish).

Chemical principles and practical aspects of electrolytic refining of Cu, Ag, Au, Pb, and Ni are reviewed. Properties and applications of ultrahigh-purity Si, Be, Ti, Ba, Ge, and Zr and methods of ultrapurification of these materials are discussed. (Rev. Metal Lit.)

49702 APPLICATION OF HIGH-SPEED PROCEDURES IN POWDER METALLURGY. Gentzsch, Gerhard. Klepzig Fachber., 75: 313-22(May 1967). (In German).

Discussions are presented on the development of high speed procedures, such as the application of explosive material, underwater sparks, compressed gas, and magnetism for the deformation or treatment of metals. Characteristics of all these procedures are the high deformation or energy speeds with which the machining operation proceeds. The application of high speed procedures is however not only confined to the deformation; they can also be used for the compression of powder. Experiments have been made concerning compression of metal and ceramic powders, on which a detailed report is given. (tr-auth)

49703 PULVERMETALLURGIE ELEKTRISCHER KONTAKTE. VOLUME 20. (Powder Metallurgy of Electrical Contacts). Schreiner, Horst. Berlin, Springer-Verlag, 1964. 247p.

A comprehensive description is given of the technologies involved in the production of electric contact materials by powder metallurgy methods. Particular subjects discussed are: production of powders, physical characteristics, methods for evaluation, mixing and blending, compacting, sintering, and impregnation. Specific alloys described include Ag–Ni, Cu–Pb, Cu–W, Ag–W, Cu–Mo, Ag–Mo, and compositions of Ag–CdO, Ag–SnO_2, metals with metal carbides, and systems of metals and metalloids. Numerous references are cited. (P.G.C.)

49704 PLATING OF BERYLLIUM FOR BRAZING. Missel, L.; Titus, R. K. (Lockheed Missiles and Space Co., Sunnyvale, Calif.). Metal Finish., 65: 59-61(Oct. 1967).

Beryllium electron windows joined to stainless steel frames are used in the Stanford Linear Accelerator. A braze system was developed to provide the joint quality required. Adherent copper plating was selected as the base. A barrier layer of electrodeposited Cu, with or without an overplate of Ni was interposed on the Be surface. A procedure for plating for brazing is given. Tensile shear tests of plate Be brazed to Ni plated 304 stainless steel show a high degree of mechanical strength. (J.C.W.)

49705 EFFECT OF MATERIAL TRANSFER MECHANISMS ON THE FORMATION OF DISCONTINUITIES IN PACK CEMENTATION COATINGS ON SUPERALLOYS. Brill-Edwards, H.; Epner, M. (Chromalloy American Corp., San Antonio, Tex.). Electrochem. Technol., 6: 299-307(Sept.-Oct. 1968).

The formation of discontinuities in aluminum-base cementation coatings on iron, nickel, and cobalt superalloys was studied. Three main classes of defect were observed in the coatings on each of these alloys, and attributed to irregular vapor diffusion through the pack, selective reaction and nucleation at the substrate surface, or nonuniform solid-state diffusion through the coating. Irregularities in the physical and chemical structure of the pack led to macroscopic variations of coating thickness, while low processing temperatures and low aluminum supply rates promoted irregular nucleation and growth at high-energy sites on the substrate surface. High deposition temperatures were conducive to more uniform nucleation and growth, whereas low aluminizing potentials encouraged sigma-phase formation and entrapment of pack powder particles. (auth)

49706 PRODUCTION OF NUCLEAR REACTOR FUEL ELEMENT COMPONENTS. Coulter, Robert Smith (to United Kingdom Atomic Energy Authority). British Patent 1,127,667. Sept. 18, 1968. Filed July 21, 1966.

A method of producing a reactor fuel element is described which consists of casting molten uranium aluminum alloy containing nuclear fuel material into tubular form and reducing the wall thickness of a tubular blank from the cast tube by subjecting the blank to rolling. In rolling the blank is positioned between two rolls of the mill designed to reduce spread. The mill is designed on the cantilever principle or it may use bearings which can be positioned after the blank is positioned between the rolls. (F.S.)

Properties Evaluations

Refer also to abstracts 48978, 48982, 49042, 49044, 49760, 49778, 50734, and 50737.

49707 (AGN-8289(Vol.1)) EVALUATION STUDY OF HASTELLOY X AS A NUCLEAR CLADDING. VOLUME I. OXIDATION AND STRUCTURAL STABILITY INVESTIGATIONS. Final Technical Report. Clarke, W. L. Jr.; Titus, G. W. (Aerojet-General Corp., San Ramon, Calif. Nuclear Div.). June 1968. Contract AT(04-3)-368. 253p. Dep. CFSTI.

The results are presented in sections on specimen preparation, aging procedures, evaluation techniques, structural stability studies, mechanical properties data, oxidation characteristics and analysis of data. (J.R.D.)

49708 (AWRE-O-38/68) EXPERIMENTS TO IMPROVE THE MECHANICAL PROPERTIES OF WROUGHT URANIUM. Tilbury, P. D. (Atomic Weapons Research Establishment, Aldermaston (England)). June 1968. 8p. Dep. CFSTI. UK 1s. 9d.

It is sometimes difficult in wrought and salt annealed alpha-uranium to achieve a room temperature elongation or more than 5%. Investigations were made into two possible methods of overcoming this difficulty, vacuum annealing to reduce hydrogen content, and warm working. The effect of nickel plating, which is used for corrosion resistance, upon the mechanical properties of vacuum annealed material was studied, as it was considered possible that the preparatory etching and plating process might re-introduce hydrogen. (auth) (UK)

49709 (BARC-325) THERMAL ACTIVATION IN ZIRCONIUM–CARBON ALLOYS. Das Gupta, P.; Arunachalam, V. S. (Bhabha Atomic Research Centre, Bombay (India)). 1968. 18p. Dep.

The effect of temperature and strain-rate on the yield and flow of zirconium containing about 1.4 at. % carbon has been examined at different temperatures between 77 and 700°K. The above measurements were coupled with strain-rate change tests so that all the deformation parameters associated with thermal activation could be evaluated. The results of these measurements showed that in pure iodide zirconium (principal impurity: 0.09 at. % O), the thermal component of flow stress and its activation energy are increased with the addition of carbon. This effect is strongly felt only during the first stage of thermal activation where impurities are rate-controlling. At higher temperatures, where the Peierls–Nabarro force is likely to be rate-controlling, the effect of carbon is negligible. With impure zirconium containing large concentration of interstitials (~1 at. % O), addition of carbon does not alter the activation parameters associated with the thermally activated deformation significantly. This is discussed on the basis of the potency of carbon as a hardener compared to oxygen. (auth)

49710 (CEA-R-3439) DIFFUSION IN THE URANIUM–PLUTONIUM SYSTEM AND SELF-DIFFUSION OF PLUTONIUM IN ϵ PHASE. Dupuy, Michel (Commissariat a l'Energie Atomique, Fontenay-Aux-Roses (France). Centre d'Etudes Nucleaires). 1967. 134p. (In French). Dep.

Thesis. Submittted to Paris Univ., France.

A survey of Pu–U phase diagrams confirms American and English figures relating to Pu solubility in αU (15% at 565°C) and in the ζU phase (74% at 565°C). Interdiffusion coefficients, for concentrations of Pu less than 15% were determined in a temperature range from 410 to 640°C. Variations were between 0.2 and 6.10^{-12} cm^2 sec^{-1}. The activation energies varied between 13 and 20 kcal/mole. Results of examination by x-ray microanalysis, micrography, and α autoradiography indicated important grain boundary diffusion of Pu in αU at 410°C. Self-diffusion of Pu in ϵ phase (bcc) was found to obey Arrhenius's law: $D = 2.10^{-2} \exp -(18500/RT)$. But this activation energy doesn't follow empirical laws generally accepted for other metals. It has analogies with "anomalous" bcc metals, βZr, βTi, βHf, and γU. (P.G.C.)

49711 (GEAP-5607) FATIGUE CRACK GROWTH IN NUCLEAR REACTOR PIPING STEELS. Brothers, A. J. (General Electric Co., San Jose, Calif. Atomic Power Equipment Dept.). Mar. 1968. Contract AT(04-3)-189. 56p. Dep. CFSTI.

Fatigue crack growth rates were measured for three steels, Type-304 stainless, A-212B carbon steel, and chromium-molybdenum steel A387D, used for nuclear reactor piping, under variations in temperature, cyclic frequency, mean stress levels, and tension versus bend loading. The application of procedures for estimation of crack growth rates is discussed as a basis for structural design. (P.G.C.)

49712 (GEAP-5624) ZIRCALOY-CLAD UO_2 FUEL ROD EVALUATION PROGRAM. Quarterly Progress Report No. 2, February 1968–April 1968. Megerth, F. H. (comp.) (General Electric Co., San Jose, Calif. Nuclear Fuels Dept.). May 1968. Contract AT(04-3)-189. 34p. Dep. CFSTI.

The operation of Assembly SA-1 during this period was limited to three days. The Dresden reactor was shut down for refueling and general maintenance. Assembly SA-1 was leak tested by the sipping technique with no indication of fuel rod failure. The estimated average and peak exposure values for SA-1 remain at 7.5×10^{20} fissions/cc (27,200 MWd/stU) and 12.2×10^{20} fissions/cc (44,500 MWd/stU), respectively. Examinations and analyses were conducted on the 10 fuel rods permanently removed from Assembly SA-1. Relative burnups and power on both a rod-to-rod basis and axial location on a given rod basis were determined from

gamma scans on all rods. Data obtained with a germanium (lithium) detector system indicated that the rod-average burnups of the highest exposure rods in the group (A13 and A41) were about 20% greater than those of the lowest exposure rods (A4 and B70). The axial gamma profiles of the 10 rods were of similar shape. The ratios of axial peak burnup to average burnup for the different rods ranged from 1.15 to 1.30. Neutron radiographs taken of six rods revealed a few 1 to 2 mm gaps in the fuel columns at pellet interfaces. Fracturing or marked cracking was detected in about 5% of the pellets and occurred to varying degrees in all rods at random locations. The neutrographs did not reveal any anomalies in either the end plugs or the heat transfer portion of the tubing. However, uninterpretable dark spots were noted within the plenums of three rods. Analyses of the chemically removed crud solutions from the six rods indicated that nickel, iron, copper, and chromium were the principal metallic elements present. The average deposition of these four elements combined was approximately 275 mg/dm^2 of fuel rod surface. Nickel constituted approximately 65 to 75% of this combined weight. Five of the fuel rods were punctured and the contained free gases were collected. The gas contents ranged from 4.7 to 9.5 cc (0.28 to 0.58 in.^{3}). The internal void volumes of these rods ranged from 2.6 to 3.8 cc (0.16 to 0.23 in.^{3}). (J.C.W.)

49713 (GEAP-5649) SPECIFIC ZIRCONIUM ALLOY DESIGN PROGRAM. Quarterly Progress Report Nos. 20 and 21. Duncan, R. N.; Mehner, A. S.; Klepfer, H. H.; Pickett, A. E. (General Electric Co., San Jose, Calif. Nuclear Fuels Dept.). July 1968. Contract AT(04-3)-189. 26p. (EURAEC-2056). Dep. CFSTI.

Work Performed under United States–Euratom Joint Research and Development Program.

A Zr + 2.0 at. % Cr + 0.16 at. % Fe alloy (Zr–Cr) is being evaluated as nuclear fuel cladding. Zr–Cr alloy-clad fuel rods are being irradiated in the Consumers Big Rock Point reactor to a target exposure of 15,000 to 20,000 MWd/tU. The rate of fuel burnup has been approximately 800 MWd/tU (average) per month of full-power operation. The Zr–Cr alloy-clad fuel rods have accumulated a total of approximately 8000 MWd/tU average exposure. This corresponds to about 7900 hours of high-temperature, full-power, reactor operation. The long-term, out-of-pile, loop corrosion tests are continuing satisfactorily. Zr–Cr alloy samples are being tested in the loop under heat transfer conditions, and have accumulated about 6800 hours exposure. Assembly B-1, containing the irradiation test rods, was inspected during a scheduled outage. This assembly was the highest power assembly in the Big Rock Point reactor core during the cycle and had accumulated a burnup of 6250 MWd/t. Leak tests indicated the bundle was sound. Four sides of the bundle were visually examined, using a pool periscope. Nothing was observed that would indicate any degradation in either the Zr–Cr or Zircaloy-2 fuel rods. The most significant observation was that there appeared to be no difference in appearance among the power-producing rods of the different alloys — Zircaloy-2 and Zr–Cr — or with different pretreatments (etched, 300°C autoclaved, 400°C autoclaved). The dummy rods, as expected, had relatively little crud deposition and exhibited a mat black finish. Power-producing rods showed a dull black finish on the upper third of the rods where crud deposition was minimum. Bottom and top end plug regions were also examined. Corrosion of the weld and heat-affected zones appeared normal. Several rods removed from bundle B-1 were profiled. No anomalous dimensional changes were measured. (auth)

49714 (MLM-1547(tr)) DILATOMETRIC STUDY OF THE $\Delta \rightarrow \gamma$ TRANSFORMATION OF PURE PLUTONIUM. Pascard, R. Translated by J. E. Selle for Mound Lab., Miamisburg, Ohio, from pp 16-25 of Proceedings of the 2nd International Conference on Plutonium Metallurgy, Grenoble, France, April 19–22, 1960. 19p. (CONF-600403-1). Dep. CFSTI.

An abstract of this paper, prepared from the original language, appeared as NSA 16: 4460.

49715 (N-68-23642) GENERATION OF LONG TIME CREEP DATA ON REFRACTORY ALLOYS AT ELEVATED TEMPERATURES. [Progress Report], March 17–December 14, 1967. Sheffler, K. D.; Steigerwald, E. A. (TRW Equipment Labs., Cleveland, Ohio. Materials Research and Development Dept.). Contract NAS3-9439. 243p. (NASA-CR-72391; MR-9). CFSTI.

Molybdenum-base TZC and TZM alloys and tantalum-base T-111 and Astar 811C are creep tested in a vacuum environment. Test temperatures range from 1600 to 2600°F and stresses from 0.5 to 65 ksi. Test parameters have been selected to provide 0.5 to 1.0% creep in 5000 to 15,000 hours. Test results with molybdenum-base TZC and TZM show the effects of variations in composition and thermal-mechanical processing history on ½% creep life. Analysis of these data using the Larson–Miller parameter indicates that at higher stress levels and lower temperatures a specially processed lot of TZM having a somewhat higher than normal carbon content is superior to TZC in the stress relieved condition, whereas at higher temperatures and lower stresses, the behavior of the two materials is comparable. A Larson–Miller plot for 1% creep of commercial purity tantalum tubing has been constructed based upon extrapolation of five short term creep tests performed sequentially upon two specimens shows a very sharp change in the creep resistance of the pure tantalum between 1183 and 1350°F. Tests designed to evaluate the creep behavior of T-111 subjected to continuously increasing loads exhibit progressively increasing creep rates. The experimental techniques involved in these tests and various methods for prediction of continuous load life from static creep test data are discussed. (auth)

49716 (N-68-24111) CREEP OF TANTALUM T-222 ALLOY IN ULTRAHIGH VACUUM FOR TIMES UP TO 10,000 HOURS. Titran, Robert H. (National Aeronautics and Space Administration, Cleveland, Ohio. Lewis Research Center). May 1968. 18p. (NASA-TN-D-4605). CFSTI.

The long time creep behavior of fine-grained (0.016-mm) Ta-9.11W-1.91Hf-0.01C was determined over the temperature range of 2000 to 2600°F and in a vacuum of 10^{-5} torr. Creep stresses ranged from 2500 to 20,000 psi for test times up to 10,000 hours. At temperatures ranging from 2000 to 2600°F, stress levels to limit creep to 1 percent in 10,000 hours are 28,000 and 800 psi, respectively. The stress dependence of the steady creep rate was 3, and the temperature dependence of steady creep was equivalent to an apparent activation energy of 150 kcal/g-mole. (auth)

49717 (ORO-3291-8) APPLICATION OF ADIABATIC CALORIMETRY TO METAL SYSTEMS. Progress Report, September 1, 1967–August 31, 1968. Stansbury, E. E.; Brooks, C. R. (Tennessee Univ., Knoxville. Dept. of Chemical and Metallurgical Engineering). Aug. 1968. Contract AT(40-1)-3291. 21p. Dep. CFSTI.

Calorimetric methods and measurements used in the determination of the specific heat of metals and alloys are reviewed. Topics discussed include development of calorimetric standards and results of specific heat measurement on Al, Cu, Ni-base, Cr-Mo-Pd alloys and of Fe-Ni alloys. Nine references. (P.G.C.)

49718 (RMI-11) SEMIANNUAL PROGRESS SUMMARY, JANUARY–JUNE 1968. (Reactive Metals, Inc., Ashtabula, Ohio). Aug. 8, 1968. Contract AT(30-1)-1405. 56p. Dep. CFSTI.

For increased metal utilization, the upset-forging process is applied for uranium fabrication. The operational problems and optimization of upset-forging as a production process are successful. Co-extrusion billets for Hanford have been processed. Parameters for the sizing of Oerter size fuel cores to dimensional specifications have been developed, successfully extruded, and sized to Mark VR Oerter precision extrusion tolerances. Studies were made of the effects of non-uniform cooling as a source of ovality using the vacuum furnace. Cold roll straightening of uranium was investigated as an economical and efficient alternative to warm roll straightening and is employed on Mark 30 production. A controlled comparison of the step seal and taper seal liners was made. The step seal liner was superior for precision extrusion. The taper seal liner will be used for regular production material. (J.C.W.)

49719 (TRG-Report-1293) CONTRIBUTION TO THE THEORY OF DEFORMATION AND FRACTURE. Gittus, J. H. (United Kingdom Atomic Energy Authority, Risley (England). Reactor Group). 1966. Reprinted 1968. 38p. Dep. CFSTI. UK 5s. 0d.

A theory of deformation and fracture for metals under monotonic and cyclic stresses is developed from an analysis of line- and point-defect movements. The mean velocity of dislocations in a statistical assembly is first computed and used to define the stress and temperature dependence of steady-state creep rate. Then the time and strain dependence of dislocation density is derived leading to an expression for transient creep. Confirmatory data on dislocation density, creep and stress-strain are cited. Fracture by the nucleation and growth of grain-boundary voids or by crack propagation is analyzed. The probability of failure in stress rupture, owing to temperature, stress, pressure, grain size, and neutron irradiation are deduced and compared with experiments. A general fatigue law relating the probability of survival with a (complex) history of stress changes is developed and suitably simplified versions are verified with experimental data. (auth)

49720 (UCRL-71233) BONDING STRAIN GAGES OR OTHER DEVICES TO BERYLLIUM METAL SURFACES. Dittbenner, Gerald R. (California Univ., Livermore. Lawrence Radiation Lab.). Aug. 13, 1968. Contract W-7405-eng-48. 10p. Dep. CFSTI.

The most favorable and least hazardous surface preparation technique for bonding strain gages or other devices to beryllium metal is to etch the surface with a mild acid solution, rinse in running tap water, and clean with Neutralizer (a proprietary product). This process has been used successfully to bond all types of strain gages and adhesives to beryllium specimens. (auth)

49721 METHOD OF WELDING METAL PIECES BY HAMMERING. Volta, Giuseppe; Perona, Giovanni (to EURATOM). British Patent 1,125,809. Sept. 5, 1968. Priority date Oct. 20, 1964, Italy.

The welding procedure between tubes of steel and Zircaloy by hammering is described. The tubes to be welded are overlapped in a protective tubular casing of the same material as one of the tubes to be welded and is incorporated in the weld with the hammering. A mandrel is inserted before the hammering begins. Examples are given of welding Type 18/8 stainless steel and Zircaloy-2 tubes. (J.C.W.)

49722 FRICTION AND WEAR PERFORMANCE OF SOFT METAL FILM LUBRICANTS IN AIR AND VACUUM TO 10^{-10} TORR. Harris, C. L.; Read, J. E.; Thompson, J. B. (Space and Weapons Research Lab., Frimley, Eng.). Lubric. Eng., 24: 230-7(May 1968).

Sliding friction and wear characteristics of soft metal film lubricants deposited on hardened steel substrates have been evaluated in ultrahigh vacuum to 10^{-10} torr. The apparatus and techniques used are described. The sliding experiments were conducted over a range of speeds from 1 to 230 cm/sec utilizing a $^3/_{32}$-in.-dia hemispherically ended rider loaded with a force of 10 g against the face of a flat rotating disk specimen of $1^1/_4$-in.-dia. The effects of film application techniques and comparative performance in both air and ultrahigh vacuum environments have been studied. Electrodeposited films of the soft metal lead have been shown to be effective in reducing both wear and friction of tool-steel sliding surfaces in vacuum. The performance of lead as a lubricant was found to be significantly better in vacuum than in air. (IAA)

49723 INFLUENCE OF STRAIN RATE ON YIELD POINT PHENOMENA IN TANTALUM. Pink, E. (Metallwerk Plansee AG, Reutte/Tirol, Austria). J. Less-Common Metals, 16: 119-28(Oct. 1968). (In German).

Strain-rate-dependent anomalies in room-temperature yield behavior of tantalum are found to be impurity effects. A partly quantitative explanation is that the stress increase at low strain rates is due to hydrogen atoms which segregate at dislocations and act as Cottrell atmospheres, whereas at high strain rates the yield stress is increased by a Snoek effect. (tr-auth)

49724 THE ELECTRON BEAM MELTING OF THE REFRACTORY METALS. 10. CAST STRUCTURE OF ELECTRON-BEAM MELTED Nb ALLOY INGOTS. Takaai, Tetsuya (Hitachi Ltd., Japan). Nippon Kinzoku Gakkaishi, 32: 796-802(Aug. 1968). (In Japanese).

The metallographic features of the cast structures of electron-beam melted Nb alloy ingots were examined mainly by microscopic observation, autoradiograph, x-ray microanalysis and x-ray diffraction analysis. Contrary to expectation, the cast structure of the ingots consisted of equi-axed grains and the beta solid solution was retained at room temperature. Microsegregation of zirconium was noticed at grain boundaries and inside the equi-axed grains, forming a subgrain boundary-like structure. According to x-ray microanalysis, the estimated zirconium concentration of the segregated zone was nearly equal to the concentration of the final liquid in the freezing process of the alloys. Zirconium was also segregated macroscopically to the outer surface of the ingot, forming sharp inverse segregation. The principal cause of the inverse segregation was attributed to the effect of outgassing pressure on the zirconium-rich melt in the freezing transient layer. (NSA of Japan)

49725 MOLYBDENUM MECHANICAL PROPERTIES AFTER HYDROSTATIC EXTRUSION. Martynov, E. D.; Beresnev, B. I.; Evstyukhkin, A. I.; Rodionov, K. P.; Bulychev, D. K.; Ryabinin, Yu. N.; Mochalov, G. A. (Moscow Engineering-Physics Inst. Inst. of Physics of Metals, Moscow. Inst. of Physics of the Earth, Moscow). Fiz. Metal. Metalloved., 25: 357-60(1968). (In Russian).

The effect of hydrostatic extrusion on the mechanical properties of sintered and hot-forged, or cast and hot-extruded TsM-2A molybdenum (low alloyed with titanium and zirconium) has been investigated. Initial specimens of extruded or forged molybdenum were vacuumed annealed at 1000 and 800°C, respectively, for 1 hr. They were hydrostatically extruded in one pass into rods 7 mm in diameter with 10-80T reduction at 8 + 2 mm/sec. It was found that hydrostatic extrusion significantly improved the mechanical properties and structure of molybdenum. The density of sintered molybdenum increased from 9.2 to 9.4 g/cm³ in the initial condition to 10.2 g/cm³ after 50% reduction; the tensile strength, impact strength, and ductility increased with increasing reduction, particularly over 50%. The same improvements were observed in forged and sintered molybdenum. The strength of extruded TsM-2A molybdenum increased from 70 to 110 kg/mm²; the elongation was reduced but remained satisfactory (28 to 18%). (auth)

49726 CREEP STUDY ON HIGH-PURITY POLYCRYSTALLINE BERYLLIUM. Borch, N. R. (Univ. of California, Livermore); Hauber, J. R. Contract W-7405-eng-48. Trans. Met. Soc. AIME, 242: 1933-6(Sept. 1968). (UCRL-70779).

A study was made on the creep behavior of cast and extruded SR grade beryllium. It is shown that, for stresses below about 1000 psi in the temperature range 760 to 850°C, the creep behavior is nearly exactly described by the Nabarro–Herring mechanism. The activation energy is apparently that for self-diffusion, 42 ± 2 kcal per mole, below 1000 psi, but it rises to 88.6 kcal per mole at higher stresses. The stress exponent is 4.5 at the higher stresses. Tertiary creep in this material is clearly related to void formation apparently caused by grain boundary sliding. (auth)

49727 HEATS OF SOLUTION AND HEATS OF COMPOUND FORMATION IN THE LANTHANUM–TIN SYSTEM. Guadagno, J. R.; Pool, M. J.; Shen, S. S.; Spencer, P. J. (Univ. of Denver). Trans. Met. Soc. AIME, 242: 2013-14(Sept. 1968).

The heats of solution of lanthanum in tin solutions were investigated using a calorimeter. Measurements were made at 725, 750, and 775°K and at compositions up to 2.21, 4.76, and 5.25 at. % respectively. The heats of solution remained constant at its limiting value up to the highest lanthanum concentration. Using the measured data for the compounds $LaSn_3$ and La_2Sn_3 and pure La, a value was calculated for the heat of formation of $LaSn_3$ and La_2Sn_3 at 273°K. (J.C.W.)

49728 PROGRESS IN RESEARCH ON CYCLE-DEPENDENT FATIGUE. Broom, Trevor (Central Electricity Research Labs., Surrey, Eng.). Mater. Sci. Eng., 3: 138-44(Sept. 1968).

The fatigue behavior of fcc metals at temperatures below 0.4 Tm is discussed, where Tm is the algebraic mean of the maximum and minimum temperature in one cycle. Discussions are included on fatigue hardening, fatigue softening, crack initiation, and crack growth. Fatigue at temperatures above approximately 0.5 Tm where diffusion-dependent effects unambiguously appear is also examined along with fatigue of copper. 74 references. (J.C.W.)

49729 CRITICAL CURRENT OF SUPERCONDUCTING Nb(Cb)–Zr–Ti ALLOYS IN HIGH MAGNETIC FIELD. Doi, T.; Ishida, F.; Kawabe, U.; Kitada, M. (Hitachi Ltd., Tokyo). Trans. Met. Soc. AIME, 242: 1793-1800(Sept. 1968).

The relations between microstructures and critical current density in transverse magnetic field were experimentally investigated due to each transformation of the β to $\beta' + \beta''$ phases at 700°C for superconducting Nb–40 at.% Zr–10 at.% Ti alloy and the β to $\alpha + \beta$ phases at 500°C for superconducting Nb–5 at.% Zr–60 at.% Ti alloy. The microstructures were mainly examined using replication electron microscopy. The β' or α precipitates were found to pin down magnetic flux lines in these alloys. The effects of precipitation upon the critical current density were discussed in relation with the size, spacing, and character of these precipitates. (auth)

49730 BRAZING AS A TECHNIQUE IN THE FABRICATION OF POWER REACTOR FUEL ELEMENTS AND INSTRUMENTS. Friedman, G. I. (Institutt for Atomenergi, Kjeller, Norway). pp 195-207 of Fabrication of Ceramic Type Power Reactor Fuel Elements. VIII Nuclear Congress, Rome, 19–20 June 1963. Roma, Comitato Nazionale Energia Nucleare, 1967.

See CONF-193-(Vol.1).

Composition and properties of Ag-base, Ni-base, and special-purpose brazing alloys for fabrication of reactor components are described. Techniques and equipment developed for making either ductile or hard corrosion-resistant joints are discussed. (P.G.C.)

49731 TRANSPORT PHENOMENA AT LIQUID METAL–VAPOR INTERFACES USING RADIOACTIVE TRACERS. Wylie, K. F.; Dryden, C. E. (Ohio State Univ., Columbus). Nucl. Appl., 5: 263-8(1968).

A radioactive tracer technique was developed for evaluating the condensation-evaporation coefficient at the liquid-vapor interface of mercury for isothermal equilibrium. Five studies conducted at vapor temperatures of 92.1, 111.4, and 123.6°C resulted in a coefficient of 1.02 ± 0.05 for a clean system. Vis-

ual examination during the exchange process showed that film condensation occurred during the studies. (auth)

49732 FRACTURE TOUGHNESS AND HEAT TREATMENT CHARACTERISTICS OF HEAVY THICKNESS Ni–Cr–Mo HIGH STRENGTH STEELS FOR NUCLEAR REACTOR VESSELS. Susukida, Hiroshi; Tuzi, Ichiro (Mitsubishi Heavy Industry, Ltd., Japan). Mitsubishi Juko Giho, 5: 396-405 (July 1968). (In Japanese).

Fracture toughness, which is one of the essential factors for steels used for nuclear reactor vessels, was investigated by WOL test on two kinds of Ni-Cr-Mo high strength steel plates (modified HY 80 steel, thickness 200 mm and modified HY 100 steel, thickness 150 mm) and one Ni-Cr-Mo high strength steel forging (modified HY 100 steel, thickness 150 mm) and the correlations of criteria between various notch toughness testing methods were obtained. The effects of quenching, tempering and stress relieving treatment (heating temperature, holding time, and cooling rate from these temperatures) as well as the effect of long-term heating on impact properties of the above-mentioned steels were also investigated. As a result, fundamental data which are useful for establishing standard heat treatment procedure to be employed after forming and welding of reactor vessel steel were obtained. (NSA of Japan)

49733 ANISOTROPY IN THE HARDNESS OF METALLIC BERYLLIUM. Tsuya, Kazuo (National Research Inst. of Metals, Tokyo). Kinzoku Zairyo Gijutsu Kenkyusho Kenkyu Hokoku, 11: No. 1, 47-56 (Mar. 1968). (In Japanese).

The effect of the crystal orientation and of the pressing-element orientation upon the hardness of beryllium single crystal was studied in the temperature range of room temperature to 400°C. And, the influence of grain boundaries on the hardness, and the relation with the hardness of a polycrystalline material were also examined. It was found that the change in the anisotropy of hardness with the temperature can be explained by the change in the deformation form with the temperature. The deformation marking, occurring around a pressing mark, agreed well with the calculated orientation factor. It was observed that the effect of adjoining crystal-grains on the hardness near the grain boundary appears only when the difference in the orientations of the grains is large, and that the aggregate structure can be estimated qualitatively from the anisotropy in hardness of the polycrystalline material. (NSA of Japan)

49734 EFFECT OF HYDROGEN ON THE MECHANICAL PROPERTIES OF NIOBIUM. Sasaki, Yasuo (Kyoto Univ.); Kimura, Keizo. Kinzoku Zairyo Gijutsu Kenkyusho Kenkyu Hokoku, 11: No. 1, 41-6 (Mar. 1968). (In Japanese).

The mechanical properties of niobium with the addition of hydrogen were studied. Niobium wires were heated in purified hydrogen at 450°C at 1 atm for several hours, to absorb it into the wire, and then cooled in argon gas. Nb alloys, containing less than 8 at.% of hydrogen, were thus prepared. The hydrogen existed in the wires either as dissolved or as hydrogen compounds, with the compounds changing continuously in shape from the plate to the lens form with the increasing hydrogen content. A tensile test was made on the alloys at room temperature, −75 and −195°C, while the bending test was performed at room temperature. The tensile yield stress increased linearly with addition of hydrogen, while the elongation decreased rapidly, the elongation of 5 at. % H–Nb alloy being half that of niobium at room temperature. In the tension at lower temperatures, considerable decrease in elongation and gradual increase in yield stress, and brittle fracture for the high H-content alloys, were observed. At −75 and −195°C, considerable decrease in bending was observed. The bending decreased rapidly with about 2 at. % H content, and beyond it, the bending angle approached 0°. With less than 2 at. % H, the bending angle was over 160°. (NSA of Japan)

49735 STUDIES ON COLUMBIUM ALLOYS. Kato, H.; Babitzke, H. R. Kinzoku Zairyo Gijutsu Kenkyusho Kenkyu Hokoku, 11: No. 1, 23-39 (Mar. 1968). (In Japanese).

The studies were made in an attempt to obtain Nb alloys having larger high-temperature strength and higher oxidation-resistance, and better workability than ordinary Nb alloys. A number of Nb alloys, containing C, Al and Cr, were prepared by melting, and the effects of the alloying elements were examined on the workability, recrystallization, oxidation-resistance, and mechanical properties. Such additions were made until the solid-solution and the precipitation hardening appeared. As the result, three Nb alloys were obtained with fair oxidation-resistance at 1,000°C and tensile strength 18.3 to 22.6 kg/mm^2 at 1,400°C. In comparing with commercially available B-66, the superiority of the alloys was shown. (NSA of Japan)

49736 METHOD OF HEAT-TREATING WELDED STEEL PRESSURE VESSELS. Nichols, Roy Woodward (to United Kingdom Atomic Energy Authority). British Patent 1,129,044. Oct. 2, 1968. Filed July 15, 1966.

A method is given of heat treating a carbon steel or low alloy steel fusion welded pressure vessel. The vessel is heated within the range of 475 to 650°C and then pneumatically pressurized to a proof test pressure. The vessel is then simultaneously heated and pressurized at the selected temperature necessary to relieve the stress. (J.C.W.)

49737 HIGH-TEMPERATURE LOW-CYCLE FATIGUE: SURVEY OF BRITISH WORK. Benham, P. P. (Queen's Univ., Belfast). Exp. Mech., 8: 309-18 (July 1968).

Work relating to thermal fatigue in metals is reviewed. A study made of the strain cycling of stainless steel 20Cr−25Ni−Nb fuel cans is described which was designed to simulate the loading arising from coolant, external pressure, and changes in diameter of the contained-UO_2 fuel pellets. It was found that ribbed cans were not necessarily stronger than the plain type. Fuel can material was also subjected to push-pull strain cycling using 20 Cr−25Ni−0.7Nb stainless steel at constant temperatures of 25, 650, and 750°C. At 25°C, an electropolished surface increased endurance by a factor of 3 compared with a machined surface, but this difference was not found at high temperature. Further work being conducted in push-pull includes Nimonic PE 16 at 750°C and 18 Ni maraging steels at 250, 300, and 480°C. Two features so far emerging are a distinct slope discontinuity in ϵ_p−N plots and marked cyclic strain softening following an initial period of rapid cyclic hardening. The effect of creep on high-strain fatigue of a low-carbon high-manganese pressure-vessel steel was examined. The principal results of various fatigue/creep tests are described. It was concluded that there was a detrimental mutual interaction between creep and fatigue in these tests and it was tentatively proposed that a failure criterion could be based on a summation of the fractional fatigue and creep components. Further studies are being made into the high-strain fatigue of 20Cr−25Ni−1Nb stainless-steel fuel cans due to thermal cycling of advanced gas-cooled reactors. (BBB)

49738 BOILING OF LIQUID ALKALI METALS. Collier, J. G. Chem. Process Eng., 49: 167-73; 180 (Aug. 1968).

Characteristics of sodium under boiling conditions are reviewed and discussed. The differences and similarities between the behaviour of boiling non-metals and boiling metals are emphasized and related to the current state of knowledge of the boiling process in both natural and forced convection systems. (UK)

49739 NUCLEAR MATERIALS RESEARCH, THE SCOPE AND NEED. Mooradian, A. J. (Whiteshell Nuclear Research Establishment, Pinawa, Manitoba). Eng. J. (Montreal), 50: 54-7 (Oct, 1967).

Development of structural components and coolants subjected to nuclear reactor irradiation are discussed with emphasis on present needs and possible future trends. It is thought unlikely that revolutionary changes in materials will take place in nuclear reactors within the next 10 years. Under the pressure of early commercial application, the technology of nuclear materials has advanced much more quickly than the science. The prospects for future breakthroughs are now handicapped by the lack of a sound scientific foundation. Whereas relatively successful development of core materials has been achieved, much remains to be done in applying what is already known to the conventional parts of a nuclear plant. Further fundamental advances in materials and their practical application will require a broad interdisciplinary approach. Evolutionary developments in the Zr alloys should give designers materials which show significant improvements in design stress and/or operating temperature. A prediction is made that design stress at 300°C can be improved by between 75 and 100% over that of Zr-2. The key material here appears to be a Zr 2½ Nb alloy, which in the quenched and tempered condition can be considered for a design stress of 23,000 psi as opposed to 16,000 psi for Zr-2. Possibly this figure could be increased to ~30,000 psi. Further improvements may be expected in the corrosion properties by minor additions to the basic alloy. Another profitable line of work associated with Zr alloys is an attempt to produce dispersion hardened materials exhibiting superior creep properties at elevated temperatures. (BBB)

49740 TIME/TEMPERATURE DEPENDENCE OF THE HARDNESS OF DISPERSION-STRENGTHENED ALUMINIUM ALLOYS. Kellerer, H.; Piatti, G. (EURATOM-CCR, Ispra, Italy). J. Nucl. Mater., 27: 245-56 (Sept. 1968).

A systematic study has been made of the high-temperature hardness of Al-Al_2O_3 (SAP) alloys. Different materials with oxide percent varying from 4 to 14.5 have been tested in air at temperatures between 20 and 600°C. Indentation creep tests have

also been performed on SAP 7% Al_2O_3 at 350 and 450°C for times up to 4000 min. The time-temperature dependence can be described by the equation $H = H_0 \cdot \exp\{-B'T(\ln t - C)\}$, where H is the Brinell hardness, H_0, B' and C are constants, T and t are absolute temperature and time respectively. For t = const., the above relation coincides with the Ito-Shishokin equation, $H = H_0 \cdot \exp(-BT)$, the validity of which is also confirmed for dispersed phase materials. The results have been correlated with the mechanical properties (creep and tensile test) of the SAP alloys. (auth)

49741 AGING FEATURES OF COPPER–BERYLLIUM ALLOYS DURE TO THEIR THERMODYNAMIC PROPERTIES. Gavrilenko, L. G.; Malkin, V. I.; Mogutnov, B. M.; Pokidyshev, V. V. (Inst. of Metal Physics, Kiev). Fiz. Metal. Metalloved., 25: 469-72 (1968). (In Russian).

Some features of the decomposition of supersaturated solid solutions are largely conditioned by the concentration dependence of the free energy of their formation. In particular, it is known that the occurrence of segregations termed Guinier-Preston zones during the first stages of decomposition of the solutions of Al–Cu, Al–Ag and Al–Zn is associated with the presence of a metastable demixing region in the supersaturated solid solution. Since the existence of an immiscibility region is attributable to the positive heat of formation of alloys, it may be expected that in systems in which aging is accompanied by the occurrence of Guinier-Preston zones the formation of solid solutions must be accompanied by absorption of heat. In this connection it was of interest to clarify the possibility of existence of a metastable immiscibility region in the Cu–Be system. Accordingly thermodynamic properties of the system Cu–Be (up to 35 at. % Be) were investigated by the emf method at 1000 to 1135°K in an argon atmosphere. The findings were used to plot curves of the concentration dependence of free energy (for 1000°K) and integral heat of formation of alloys in the α-region. These curves indicate that the formation of the solution of Cu in Be, as well as that of Be in Cu, is accompanied by release of heat. It is logical to assume that if the solid solution of Cu and Be exists over a broad range of concentrations, the enthalpy of its formation must be negative throughout, i.e., a demixing region must be absent in such a solution. Hence also the decomposition of the supersaturated solid solution of Be in Cu cannot be accompanied by the formation of Guinier-Preston zones, i.e., it cannot be accompanied by the formation of segregations resembling those observable in the alloys Al–Cu, Al–Ag and Al–Zn. (ATD)

49742 SPECIFIC HEAT OF $NbFe_2$ AT ELEVATED TEMPERATURES. Rezukhina, T. N.; Drobyshev, V. N.; Liu, Chin-hsiang. Izv. Akad. Nauk SSSR, Metal., No. 2, 215-18(1968). (In Russian).

The specific heat of $NbFe_2$ was investigated with the aid of a massive calorimeter with an isothermal envelope at 293 to 1173°K. The mean molar specific heat of $NbFe_2$ is derived as $\bar{C}_{p\text{-cal}} = 1290 + 8.112 \cdot 10^{-3}(T - 293.5)$ and from the ratio $\bar{C}_p = (1/T - 293.5)\int_{293.5}^{T} C_p dT$ between mean and true specific heats the true molar specific heat of $NbFe_2$ is derived within the same temperature range as $C_{p\text{-cal}} = 8.15 + 16.22 \cdot 10^{-3} T$. It was found that a deviation of $NbFe_2$ specific heat from the additiveness rule is clearly associated with the decrease in the number of degrees of freedom in the $NbFe_2$ lattice, owing to the formation of strong interatomic bonds that are, up to a point, of a covalent nature (covalent bonding). (ATD)

49743 EFFECTS OF BERYLLIUM OXIDE ON THE BRAZE WELDABILITY OF BERYLLIUM. Hicken, G. K. (Dow Chemical Co., Golden, Colo.). Weld. J. (N.Y.), 47: 364s-70s(Aug. 1968).

An investigation was undertaken to determine the effects of beryllium oxide on the braze weldability of beryllium. An aluminum shim was preplaced between the pieces of beryllium prior to normal electron beam welding. Partial penetration welds were made in hot pressed powder beryllium 1/4 in. thick. The beryllium contained varying quantities of beryllium oxide from 0.90 to 2.5 wt %. Two statistical programs were conducted to determine the effects of weld travel speed, number of welding passes, and beryllium oxide content on the braze weldability of beryllium. Weldability was defined by surface appearance, porosity content, and tensile strength. Welds made in the different grades of beryllium showed that beryllium oxide content greatly influenced the weldability of beryllium. Increasing the beryllium oxide content resulted in greater amounts of weld porosity. Weld tensile strength decreased as the oxide content increased. Welds with tensile strengths in excess of 42,000 psi were made in beryllium containing 0.90 wt % beryllium oxide. Increasing the number of welding passes from one to five reduced the amount of weld porosity. Weld travel speed did not have a significant effect on porosity or strength. (auth)

49744 CHANGE OF CHEMICAL POTENTIAL OF OXYGEN IN LIQUID METALS AND LIQUID OXIDE PHASES. Goto, Kazuhiro; Sasabe, Minoru; Someno, Mayumi (Tokyo Inst. of Tech.). Trans. Met. Soc. AIME, 242: 1757-9(Aug. 1968).

A method was developed to measure the change in the chemical potential of oxygen in liquid metals and in liquid oxides, with respect to time, when the oxygen potential in the gas phase changes. (auth)

49745 THE INFLUENCE OF NITROGEN, TITANIUM, AND ZIRCONIUM ON THE BORON HARDENABILITY EFFECT IN CONSTRUCTIONAL ALLOY STEELS. Kapadia, B. M.; Brown, R. M.; Murphy, W. J. (U. S. Steel Corp., Monroeville, Pa.). Trans. Met. Soc. AIME, 242: 1689-94(Aug. 1968).

An investigation was conducted to study the influence of nitrogen, titanium, and zirconium on the boron hardenability effect in a low-carbon constructional alloy steel. The experimental steels investigated exhibited a significant variation in hardenability, the variation being dependent on the interactions of boron, titanium, and zirconium with the nitrogen. Only the boron not combined with nitrogen was effective in increasing hardenability. Titanium, and with lesser effectiveness zirconium, combined with available nitrogen, thereby protecting the boron. The hardenability effect was related to an empirical expression for the "effective" boron content, β deduced from experimental evidence of these interactions. The hardenability effect reached a maximum at about 0.001 wt % β, and decreased somewhat as β increased further. The physical understanding of this relationship is discussed.

49746 SOME ANELASTIC PROPERTIES OF ZIRCONIUM RESULTING FROM PRESTRAIN AT 77°K. Dahlberg, Edward Philip. Gainesville, Fla., Univ. of Florida, 1967. 116p. Thesis.

The mechanical hysteresis and anelastic properties of polycrystalline zirconium which result from the reversible thermally activated motion of the boundaries of deformation twins are investigated. Straight rolled polycrystalline zirconium plate stock was prestrained at 77°K in order to nucleate numerous fine $\{11\bar{2}1\}$ twins in an otherwise almost undistorted matrix. Subsequent tensile deformation at elevated temperatures showed marked deviation from linear behavior in the stress-strain curves at an initial resolved shear stress of approximately 2,500 psi, which is much lower than the normal 0.2 per cent offset yield point for this material. The development of large anelastic strain at comparatively low stress levels indicates the ease with which $\{11\bar{2}1\}$ twin boundaries are able to move. On cyclic loading at low frequencies in a tensile machine, large mechanical hysteresis energy losses were observed at −72 to 80°C. Comparative area measurements of the hysteresis loops showed the energy losses were a sensitive function of the amount of prestrain and reached a maximum at approximately 0.65 per cent prestrain. The losses were stress amplitude dependent, increased with increased temperature, and decreased with increased strain rate or cycle frequency. The anelastic strain relaxation processes were found to be controlled by a single relaxation time which varied markedly with test temperature. An activation energy for these processes was found to be approximately 23,000 calories per mole and did not vary significantly over the range of temperature used in these experiments. Results of the study led to determination of the relaxed modulus and activation volume for twin boundary motion. The kinetics of the anelastic strain development indicate that twin boundary migration may be controlled by slip deformation. The stress concentrations at the tapered twin edges are thought to induce slip deformation in the adjoining matrix. As this deformation increases or decreases, the twin either thickens or thins accordingly. The correlation between the activation energy and the activation volume for twin boundary migration with that for low temperature creep in zirconium suggests such a controlling mechanism. (Disser. Abstr.)

49747 CREEP AND STRESS RUPTURE BEHAVIOR OF VANADIUM–TITANIUM AND VANADIUM–TITANIUM–NIOBIUM ALLOYS. Boehm, Horst; Schirra, Manfred (Kernforschungszentrums, Karlsruhe, Ger.). Z. Metallk., 59: 715-23(Sept. 1968). (In German).

The creep and stress-rupture behavior of binary V-Ti and ternary V-Ti-Nb alloys were studied in the temperature range above 650°C. The results indicate the strong influence of titanium on the creep and stress-rupture behavior of the alloys. At titanium concentrations above 1% the stress-rupture strength is lowered with increasing titanium content, whereas the ultimate tensile strength increases. This effect is not affected by the niobium content. The time to rupture at high stresses is increased with increasing Nb-content. At low stresses the influence of the Nb-content decreases, so that the 10,000 hr stress-rupture strength of the V-alloys is only slightly dependent on the Nb-concentration. The strongest vanadium base alloys show higher stress rupture strength in the temperature range between 650 and 800°C than nearly all other alloys. The activation energy for creep in the

temperature range of 650 to 700°C is strongly influenced by the Ti-content whereas no influence of the Nb-content could be found. The results show that the creep and stress-rupture behavior of the V-base alloys, even at higher Ti-concentrations, is mainly influenced by the interaction between titanium and the interstitial impurities. (auth)

49748 GRAIN STABILITY AND CREEP BEHAVIOR OF Mg–Zr ALLOY ACCORDING TO ITS STRUCTURE CONDITION. DESCRIPTION OF THE CREEP MECHANISMS. Dabosi, F.; Guillaumin, J.; Pegoud, J. Mem. Sci. Rev. Met., 65: 487-503(June 1968). (In French).

The grain growth and creep behavior of Mg–Zr alloy after prolonged exposure to elevated temperatures in a CO_2 atmosphere were studied. The structure after creep was examined by micrography. The effect of precipitation of zirconium hydride at 500°C is discussed. (F.S.)

49749 OXIDATION BEHAVIOR OF Nb UP TO 1000°C. Bollenrath, F.; Poddey, P. (Technische Hochschule, Aachen). Metall, 22: 702-6(July 1968). (In German).

The oxidation of Nb between 400 and 1000°C is characterized by a strong temperature and pressure dependence of the oxide formation. Results of the study indicate that after a parabolic initial stage decreasing with increasing temperature (incubation time of the oxide formation) the oxidation follows throughout a linear time law. The linear oxidation pattern begins after a break-away reaction which is connected with the appearance of crystalline niobium pentoxide nucleation sites on the metal surface. The oxidation products form two layers, one adherent gray internal layer of several oxide phase and the other a porous white external layer of Nb_2O_5. The oxidation at atmospheric pressure shows under 800°C three regions of different temperature dependence: 400 to 500°C, 500 to 600°C, and 600 to 800°C. In the first two regions, the oxygen a constant free access to the metal surface because of fissure formation. The formation and the growth of Nb_2O_5 seeds were regarded as a velocity-determining reaction. Under 500°C Nb_2O_5 is the only detectable oxide phase. Under 600°C metastable suboxide phases appear because of the incomplete equilibrium appearance from supersaturated niobium mixed crystals. These have high oxygen concentration in the metal surface because of their large free energy. Between 500 and 600°C the precipitation of the suboxide phase NbO_x was observed. The pentoxide formation proceeding accelerated over the suboxide causes an increase of the oxidation rates up to 585°C. Over 600°C there is a change of the oxidation mechanism. The suboxide disappears and the stable oxides NbO and NbO_2 corresponding to the equilibrium state appear. These form in the gray interior oxide layer a diffusion barrier of constant thickness which reduces the oxidation rate. At reduced pressures, the equilibrium is attained at lower temperatures. (tr-auth)

49750 EFFECT OF CYCLIC STRESSING ON THE YIELD BEHAVIOR OF MOLYBDENUM. Dubensky, Robert George. Iowa City, Iowa, Univ. of Iowa, 1968. 112p.

Thesis.

The effect of stress cycling on the yield behavior of low carbon steels has been investigated. It is reported that the upper yield point was removed under certain stress precycling conditions. This investigation presents the hypothesis that similar changes are induced in the yield behavior of certain other body-centered cubic metals. This hypothesis was partially verified by showing that cyclic stressing caused a change in the yield point behavior of molybdenum. Autographic tensile load-deformation curves were plotted after precycling the molybdenum specimens. The range of fully reversed axial stresses was from below the fatigue limit to approximately the yield point. Quantitative values, of both the stress magnitude and the number of stress precycles that remove the yield point, were determined. The effect of aging on the stress cycling induced changes in yield behavior was determined. A model was presented to explain the yield point removal by stress precycling in body-centered-cubic metals in terms of dynamic dislocation concepts. (Disser. Abstr.)

Structure and Phase Studies

Refer also to abstract 49729.

49751 (CALT-473-28) A STUDY OF DISLOCATION MOBILITY AND DENSITY IN METALLIC CRYSTALS. Annual Summary Report No. 6 [for] Period Ending July 1968. Vreeland, T. Jr.; Wood, David S. (California Inst. of Tech., Pasadena. W. M. Keck Lab. of Engineering Materials). Aug. 1968. Contract AT(04-3)-473. 10p. Dep. CFSTI.

A review of research conducted to determine the role of dislocation dynamics in the plastic deformation of crystalline solids, particularly single crystals of Fe, Mo, Al, Nb, and Zn, is presented. (P.G.C.)

49752 (COO-588-14) TRANSFORMATION CHARACTERISTICS OF ZIRCONIUM-NIOBIUM AND OTHER ALLOYS. Perkins, A. J.; Jackson, W. A.; Hehemann, R. F. (Case-Western Reserve Univ., Cleveland, Ohio. Dept. of Metallurgy). July 1968. Contract AT(11-1)-588. 35p. Dep. CFSTI.

It is postulated that the omega reaction in Ti and Zr alloys results from an instability in the parent bcc phase and represents a unique diffusionless transformation that takes place as a second order reaction. During the past year studies have been initiated to explore the generality of this concept and the relationship between this class of diffusionless transformation and classical martensitic reactions. The systems chosen for these studies involved continuation of work on Zr–Nb alloys and initiation of studies on the Hf–Nb system and the intermetallic compound Ti–Ni. Transmission microscopy and other studies revealed that an athermal omega reaction occurs in a Hf–32% Nb alloy. The diffuse streaking and other characteristics of this alloy are completely analogous to the corresponding behavior of a Zr–25% Nb alloy. The intermetallic compound Ti–Ni exhibits a classical martensitic reaction at temperatures near room temperature and a transition phase at temperatures above M_s which exhibits the diffuse streaking, reversibility and negative temperature coefficient of resistivity characteristic of omega in Ti and Zr alloys. The alloys chosen for this study appear to be appropriate for advancing understanding of the instability responsible for these transitions and for exploring the relationship between these higher order reactions and classical martensitic transformations. (auth)

49753 (LA-DC-9603) CATHODIC VACUUM ETCHING WITH HYDROGEN. Reiswig, R. D. (Los Alamos Scientific Lab., N. Mex.). [1967]. Contract W-7405-eng-36. 7p. (CONF-680614-3). Dep. CFSTI.

From 22nd AEC Metallography Group Meeting, San Diego, Calif.

The use of hydrogen has been found to produce superior results in the ion–bombardment etching of carbonaceous materials for optical microscopy. It appears that atomic, rather than molecular, hydrogen species are desirable for this purpose. In addition, this procedure may have some advantages in the etching of certain metals. (auth)

49754 DEFORMATION OF ALPHA PLUTONIUM. Nelson, R. D.; Dahlgren, S. D. (Battelle Memorial Inst., Richland, Wash.). Contract AT(45-1)-1830. Trans. Met. Soc. AIME, 242: 1865-7 (Sept. 1968).

The conditions of temperature, strain rate, and total strain favoring deformation by grain boundary sliding, slip, or deformation with concurrent recrystallization were evaluated for alpha plutonium. Grain boundary sliding and slip were studied by examining structures formed on polished surfaces with 4.5% compressive deformation. The conditions required for recrystallization were determined from compressive deformation vs time curves. At 110°C and at a strain rate of 10^{-4} per min, deformation was almost exclusively by grain boundary sliding whereas slip was the predominant deformation mode at –10°C and 10^{-1} per min. Deformation at intermediate temperatures and strain rates produced structures showing mixtures of grain boundary sliding and slip. Recrystallization occurred concurrently with deformation only after a critical strain was reached. About 14, 6, and 3% strain was required at 105, 110, and 120°C, respectively, before recrystallization started, irrespective of the strain rate in the range of 10^{-1} to 10^{-4} per min. (auth)

49755 PLASTIC DEFORMATION OF ZIRCONIUM-OXYGEN ALLOY SINGLE CRYSTALS IN THE RANGE 77° TO 950°K. Mills, D.; Craig, G. B. (Univ. of Toronto). Trans. Met. Soc. AIME, 242: 1881-90(Sept. 1968).

The deformation of zirconium single crystals containing oxygen in the range 740 to 6800 atom parts per million was examined over the range 77 to 950°K. An analysis of the deformation parameters leads to the conclusion that the rate-controlling thermally activated deformation process over the range 77 to 560°K is overcoming oxygen atoms. A thermally activated deformation process is not found between 600 and 800°K, but does occur above 800°K. (auth)

49756 THREE-DIMENSIONAL MODULATED STRUCTURE IN AN AGEING Fe–Be ALLOY. Dzhibuti, M. V.; Tyapkin, Yu. D. (Central Scientific Research Inst. for Ferrous Metallurgy, Moscow. Georgian Polytechnic Inst., Tbilisi, USSR). Sov. Phys.-Cryst. (Engl. Transl.), 13: 240-4(Sept.-Oct., 1968).

Translated from Kristallografiya, 13: 307-10(Mar.-Apr. 1968).

The initial stage of decomposition of the supersaturated solid solution in the Fe–Be alloy with 19.5 atomic % Be has been stud-

ied by diffuse x-ray scattering from micro-single crystals. It is shown that periodic modulation of the interplanar spacing of the original matrix takes place, and that this modulation, which can be described by plane waves in the ⟨100⟩ directions and exists simultaneously in all three directions (i.e., three-dimensional periodic modulation), occurs as a result of the decomposition. (auth)

49757 NICKEL INDUCED RECRYSTALLIZATION OF DOPED TUNGSTEN. Montelbano, T. (Univ. of Pennsylvania, Philadelphia); Brett, J.; Castleman, L.; Seigle, L. Trans. Met. Soc. AIME, 242: 1973-9(Sept. 1968).

Impurity-induced low-temperature recrystallization of cold-worked tungsten was investigated with emphasis on the influence of nickel on the reaction. Palladium, nickel, aluminum, manganese, platinum, and iron greatly lower the recrystallization temperature of doped tungsten, which is normally very high, but the recrystallization temperature of electron-beam zone-refined tungsten wire is slightly raised by contact with nickel. Recrystallization can be induced at low temperature by the presence of solid nickel on the surface of doped tungsten wire, but apparently not by exposure to nickel vapors alone. Approximately 200 ppM of Ni diffused into 10-mil wires at 1200°C from a deposit of nickel on the surface produced total recrystallization, whereas more than 600 ppM of Ni could be absorbed from a vapor source without altering the fibrous structure of cold-worked tungsten. Once initiated, nickel-induced recrystallization required a continued source of nickel for propagation of the recrystallization front. The solubility of nickel in fibrous 10-mil W wire was approximately 500 ppM at 1150°C, and the activation energy for penetration of the recrystallization front was 52 kcal per mole. (auth)

49758 X-RAY INVESTIGATION OF σ-PHASE IN VANADIUM–COBALT AND VANADIUM–MANGANESE ALLOYS. Nemoshkalenko, V. V.; Nagornyi, V. Ya. Ukr. Fiz. Zh., 13: 1185-91(July 1968). (In Russian).

Outer energetic band electron distribution in Co + V 56.5% and Mn + V 18.8% alloys was investigated by x-ray spectroscopy. Both alloys have the σ-phase structure. Shape, width, energetic shift, relative maximum, and integral intensities of $K\beta_5$-bands of the alloys' components were obtained. The results of the investigation can be used as the basis for an assumption that σ-phase formation is followed by considerable redistribution of electrons in outer energetic band. (auth)

49759 CRYSTALLOGRAPHIC STRUCTURE OF THE INTERMETALLIC COMPOUNDS T_3Ni, T DESIGNATING A RARE EARTH METAL OR YTTRIUM. Lemaire, R.; Paccard, D. (CEN, Grenoble, France). Bull. Soc. Fr. Miner. Crist., 90: 311-15 (July-Sept. 1967). (In French).

Cerium and europium are distinguished from other rare earths in that they have the same crystal structure for T_3Ni as they do for T_3Co and crystallize with the orthorhombic Al_3Ni (or Fe_3C) structure type. The principal structural element of this type is a rare earth trigonal prism with Ni at the center. These prisms are found only in those alloys with Ni and Co that are rich in rare earth, as for example TNi, T_7Ni_3, T_4Co_3, and T_3Co. The structure of Gd_3Ni is chosen as an example, with atomic coordinates and temperature factors for the compound described in the group Pnma; the general structure is illustrated, and interatomic distances given. For Gd_3Ni, calculated and observed intensities are compared for a polycrystalline sample. Lattice constants for the normal rare earths show the usual lanthanide contraction (for La_3Ni, a = 7.22, b = 10.24, c = 6.60 Å; for Tm_3Ni, a = 6.77, b = 9.40, c = 6.19 Å); structures for the exceptional Ce and Eu compounds are not included in the tables. (BBB)

49760 NON-MONOTONIC STRENGTHENING IN B.C.C. SOLID SOLUTIONS. Das, G. C.; Arsenault, R. J. (Univ. of Maryland, College Park). Scr. Met., 2: 495-500(Sept. 1968).

Tensile tests on chemically etched and annealed Ta–W alloy single crystals indicate that non-monotonic strengthening occurs in bcc solid solutions if the solute is of smaller atomic size and has a larger modulus than the solvent. (P.G.C.)

49761 EFFECTS OF ELASTIC ANISOTROPY ON DISLOCATIONS IN Hcp METALS. Fisher, E. S.; Alfred, L. C. R. (Argonne National Lab., Ill.). Trans. Met. Soc. AIME, 242: 1575-86(Aug. 1968).

The effects of elastic anisotropy on the dislocation in an elastic continuum with hexagonal symmetry have been investigated by computing the elasticity factors for the self-energies of dislocations in fourteen different metals at various temperatures where the elastic moduli have been reported. For most of the metals the effects of the orientation of the Burgers vector, dislocation line, and glide plane are small and isotropic conditions can be assumed without significant error. Significant effects of anisotropy are, however, found in Cd, Zn, Co, Tl, Ti, and Zr. The elasticity factors have been applied in the calculations of dislocation line tensions, the repulsive forces between partial dislocations, and the Peirls-Nabarro dislocation widths. It is predicted that the increase in elastic anisotropy with temperature in titanium and zirconium makes edge dislocations with ⟨a⟩, ⟨a + c⟩, and ⟨c⟩ Burgers vectors unstable in basal, pyramidal, and prism planes, respectively. The probability of stacking faults forming by dissociation of Shockley partials in basal planes also decreases with increasing c_{44}/c_{66} ratio, when the stacking fault energy is greater than 50 ergs per cm^2. The widths of screw dislocations with b = ⟨a⟩ in titanium and zirconium increase very significantly in prism planes and decrease in basal planes as c_{44}/c_{66} increases. (auth)

49762 DIFFUSION OF SILICON IN MOLYBDENUM. Lassner, E.; Pueschel, R.; Benesovsky, F. (Metallwerk Plansee, Reutte/Tyrol, Austria). Planseeber. Pulvermet., 16: 91-103(July 1968). (In German).

An attempt was made to determine the diffusion rate of silicon in single crystal and polycrystalline molybdenum from different donor materials (Si, $MoSi_2$, SiO_2, SiO and glass) on vacuum-annealed, capsule-shaped specimens. The diffusion layers were analyzed by means of a microprobe, the silicon phases identified and the depth of diffusion of silicon into the molybdenum matrix determined. A relationship was found to exist between the diffusion constant and the thermodynamic stability of the silicon donor, taking into account the type of silicon interphase formed and the state of aggregation of the silicon donor at the annealing temperature. Structural investigations, x-ray studies on successive layers and microhardness measurements also helped to identify the phases in the diffusion zones. The temperature dependence of the solubility of silicon in molybdenum (about 1.5 weight % at 2200°C), the decrease of the lattice constant in molybdenum solid solutions and the hardness increase with increasing silicon concentration are in good agreement with the literature data. (auth)

49763 RECRYSTALLIZATION BEHAVIOR OF SINTERED TANTALUM. Pink, E.; Kaerle, H. (Metallwerk Plansee, Reutte/Tyrol, Austria). Planseeber. Pulvermet., 16: 104-7(July 1968). (In German).

The recrystallization behavior of sintered tantalum has been investigated as a function of deformation and temperature. Compared with molybdenum and tungsten several differences have been found. (auth)

49764 SELF-DIFFUSION IN PLUTONIUM EPSILON PHASE (Bcc). Dupuy, Michel; Calais, Daniel (CEN, Fontenay-aux-Roses, France). Trans. Met. Soc. AIME, 242: 1679-83(Aug. 1968).

The study of self-diffusion of plutonium in ε phase has been carried out by the welded couples method. The tracer used was ^{240}Pu which is detected by its x-ray emission (conversion lines of uranium which are computed between 13 and 21 keV). Intensities were measured with a scintillation counter. Each layer was removed in a direction parallel to the original interface with a grinding machine and a thickness measured with a pneumatic comparator. The concentration-penetration curves obtained were corrected for the effect of heating time from room temperature to annealing temperature and for the expansion due to phase transformations of plutonium. They were analyzed by the generalized Gruzin method. Self-diffusion of plutonium in ε phase is very fast ($D \simeq 10^{-7}$ cm^2 per sec between 500 and 620°C) and the diffusion zones are 2 to 3 mm wide for annealing times ranging from 30 min up to 10 hr. The Arrhenius law gives the temperature dependence in the form: $D_{Pu} = 2 \times 10^{-2} \exp [-(18{,}500/RT)]$ (cm^2 per sec). From the point of view of self-diffusion, Puε phase falls into the anomalous bcc metals category (Tiβ, Hfβ, Zrβ, Uγ) with a low-frequency factor and an activation energy lower than those provided by standard correlations. No theory proposed hitherto to explain these anomalies (influence of dislocations, of extrinsic vacancies bonded to impurities, of bivacancies) can clearly explain the self-diffusion coefficients of plutonium. (auth)

49765 FRACTURE IN DISPERSION-STRENGTHENED NICKEL–CHROMIUM ALLOYS. Kilpatrick, D. H.; Phillips, A.; Kerlins, V. (McDonnell Douglas Corp., Santa Monica, Calif.). Trans. Met. Soc. AIME, 242: 1657-60(Aug. 1968).

The tensile failure of two dispersion-strengthened Ni-20 Cr alloys was studied and compared to the fracture of a similar alloy with no dispersoid. The fracture characteristics were studied using electron fractography and transmission electron microscopy. In all three cases, the mode of failure was found to be microvoid coalescence. The failure in the dispersion-strengthened alloys was found to have initiated at the particles. The size of the dimples in the fractographs was found to be related to the spacing of the particles, but not to the total elongation before failure. The elongation

before failure was found to be related only to the amount of dispersed phase. These results are compared to those predicted by a theoretical model of ductile failure. (auth)

49766 ALLOY CHEMISTRY OF $\sigma(\beta U)$-RELATED PHASES. I. EXTENSION OF μ- AND OCCURRENCE OF μ'-PHASES IN THE TERNARY SYSTEMS Nb (Ta)–X–Al (X = Fe, Co, Ni, Cu, Cr, Mo). Hunt, Coy R. Jr.; Raman, Aravamudhan (Louisiana State Univ., Baton Rouge). Z. Metallk., 59: 701-7(Sept. 1968).

The limits of extensions and the variations in the lattice characteristics of the $Nb_2Al(\sigma)$ and the μ-phases of Nb and Ta containing Fe, Co, and Ni are studied in several Nb–X–Al (X = Co, Ni, Cu, Cr, Mo) and Ta–X–Al (X = Fe, Co, Ni) ternary systems. $Nb_2Al(\sigma)$ dissolves large amounts of Cr and Mo, which increase the free electron concentration, but only small amounts of Fe, Co, Ni, and Cu. The μ-phases dissolve extremely large amounts of Al (to the maximum extent of 35 at. % Al in the Nb–Ni–Al, Ta–Ni–Al and Ta–Ca–Al systems) in the positions of Fe, Co and Ni. Ternary μ'-phases are found in all the Nb–X–Al and Ta–X–Al (X = Fe, Co, Ni) systems, close to the extended μ-phase fields. The M-phase occurs only in the Nb–Ni–Al system. A ternary phase, similar to the one in the Mo–V–Al system, was found out in the Mo–Nb–Al system. The occurrence and variations in the lattice characteristics of the phases are explained in terms of the sizes of the alloying elements and variations in the valence electron concentration. (auth)

49767 SUBSTRUCTURE AND MECHANICAL BEHAVIOR OF TUNGSTEN AS FUNCTION OF PRESSURE. Das, Gobinda. Cleveland, Case Western Reserve Univ., 1967. 176p.

Thesis.

The effects of the application of hydrostatic pressure on the dislocation substructure and mechanical behavior observed subsequently at atmospheric pressure have been investigated for polycrystalline tungsten. Tensile tests were conducted from 25 to 250°C at atmospheric pressure on specimens subjected previously to pressures up to 25 kilobars. Tests were also conducted at room temperature at pressures up to 11 kilobars. The substructures and fractured surfaces were examined by optical, transmission electron microscopy, and electron fractography. The ductile-brittle transition behavior of recrystallized tungsten and a tungsten-1.9 vol. % thoria alloy are essentially unaffected by pressure cycling up to 25 kilobars at atmospheric temperature. Only in tungsten containing added second-phase particles of ThO_2–HfC, were new dislocations observed, and then only for pressures above 25 kb. In a model system of helium bubbles in copper, pressure-induced dislocations were observed for lower pressures. These results are in keeping with the prediction of the continuum mechanics calculations made in the present investigation. The influence of environmental pressure on the stress-strain behavior of recrystallized PM and arc-melted tungsten at atmospheric temperature has been investigated. Discontinuous yielding is observed at above 3 kilobars and the strain to fracture increases progressively. These results and the associated changes in the dislocation substructure and fracture mode are discussed in relation to recent theoretical attempts to predict pressure dependence of fracture behavior. The limitation of current theories are demonstrated. (Disser. Abstr.)

49768 ON THE CRYSTAL STRUCTURE OF ω PHASE IN Ti–Mn AND Ti–Mo ALLOYS. Miyagi, Masakazu; Morikawa, Masaki (Osaka Univ.). Nippon Kinzoku Gakkaishi, 32: 756-61 (Aug. 1968). (In Japanese).

Crystallographic studies were made of the ω phase in titanium alloys. It is reported that the ω phase is bcc with edge length three times that of the basic bcc cell. An hexagonal structure oriented with respect to the β cell is proposed. A single crystal x-ray analysis has been carried out by using Ti-8.2% Mn and Ti-14.1% Mo alloys, and the precipitation in the Ti-Mo alloy has been observed by transmission electron microscopy. The results of photographs obtained from aged crystals showed cubic Laue symmetry. As a result of detailed intensity measurements, it was confirmed that the true ω structure is the hexagonal cell which has four orientations in each β cell with the relationship $[111]_\beta // [0001]_\omega$, $[1\bar{1}0]_\beta // [1210]$. In this experiment, no reflection was observed from the relpoints of which calculated structure factors are equal to zero. Therefore, there is no need to consider the proposed rampling plane, that is, the atomic positions may be 0 0 0; $\frac{1}{3}$ $\frac{2}{3}$ $\frac{1}{2}$; $\frac{2}{3}$ $\frac{1}{3}$ $\frac{1}{2}$ rather than 0 0 0; $\frac{1}{3}$ $\frac{2}{3}$ 0.48; $\frac{2}{3}$ $\frac{1}{3}$ 0.52. As a result of transmission electron microscopic observation, it was found that the shape of ω particles is ellipsoidal. The major axis of the ellipsoid may be parallel to the $\langle 111 \rangle_\beta$ directions and oriented with four orientations. (NSA of Japan)

49769 ON THE PHASE RELATIONS IN Nb–Zr ALLOYS. Bollenrth, F.; Klein, H. (Technische Hochschule, Aachen). Metall, 22: 683-7(July 1968). (In German).

The present state of knowledge on the Nb–Zr system and on the effect of the elements O, N, and H on the formation of the phase ratios in Nb–Zr alloys was considered. The results of present studies on the cast state, the homogenized and extended anneal state of various Nb–Zr alloys were also reported. The cast state of the alloys is characterized by a dendrite solidification with strong segregation, which can be removed by homogenization anneal at 1400°C. The phase ratios present in the samples annealed for a long period correspond to those obtained previously. For the O_2 content of the samples studied, values above the solubility limits were found, yet the data on the Nb–Zr–O system as well as in Nb–Zr alloys with O_2 content below the solubility limit suggest a β decay. In most previous studies on the phase ratios in Nb–Zr alloys, the effect of impurities, especially of interstitial elements, is not sufficiently considered. A conclusive experimental clarification of the ratios in Nb–Zr alloys will be possible only when the purest alloys with gas contents below the solubility limits can be prepared. (tr-auth)

Radiation Effects

Refer also to abstract 50748.

49770 (BNWL-SA-1812) SOME OBSERVATIONS ON THE ANNEALING OF NEUTRON-IRRADIATED SINGLE-CRYSTAL AND POLYCRYSTALLINE MOLYBDENUM. Kissinger, H. E.; Brimhall, J. L.; Mastel, B.; Bierlein, T. K. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). July 25, 1968. Contract AT(45-1)-1830. 17p. (CONF-680910-2). Dep. CFSTI.

From International Conference on Vacancies and Interstitials in Metals, Juelich, Germany.

After fast-neutron irradiation both single-crystal and polycrystalline Mo rods showed changes in length and lattice parameters. Electron microscopy indicated that defect clusters, or small dislocation loops, were smaller, 50 to 60 Å, in the polycrystalline rods as compared with 90 to 100 Å in the single crystals after a neutron fluence of 1×10^{19} n/cm^2 although the lattice parameter changes were greater in the polycrystalline specimens. (P.G.C.)

49771 (N-68-23560) ULTRAVIOLET–PROTON RADIATION EFFECTS ON SOLAR CONCENTRATOR REFLECTIVE SURFACES. Final Report, June 1965–August 1967. Gillette, R. B. (Boeing Co., Seattle, Wash.). May 1968. Contract NAS1-5251. 146p. (NASA-CR-1024). CFSTI.

The effects of proton and ultraviolet radiation on the specular and diffuse reflectance of stretch-formed aluminum, electroformed nickel, and magnesium substrate solar mirrors were studied in high vacuum at temperatures from −195 to 200°C and energies from 2 to 30 keV. Ultraviolet exposures were vacuum deposited Al, which in some cases were overcoated with Si_2O_3 or SiO_2. The most severe mechanism of radiation-induced degradation was found to be proton blistering. (auth)

49772 (NUMEC-3432-44) IRRADIATION TESTING OF PuO_2–UO_2 FUELS. Quarterly Report No. 15, January–March 1968. (Nuclear Materials and Equipment Corp., Apollo, Pa.). Aug. 1968. Contract AT(30-1)-3432. 17p. Dep. CFSTI.

Capsule Nu-19 containing 5 fuel elements of 20 wt % PuO_2–UO_2 prepared by coprecipitation and mechanically blending and clad in 316L stainless steel were irradiated in the GETR to 100,000 MWd/t. Coprecipitation fuels were substoichiometric (O/M = 1.98) and mechanically blended fuels were substoichiometric (O/M = 1.98) and stoichiometric. Other as-fabricated parameters are given. Irradiation conditions were 9 kw/ft peak heat generation rate and clad and fuel centerline temperatures of 600°C and 2200°C, respectively. Neutron radiographs of the capsule are shown. Gamma scars are recorded and discussed. The isotopic analysis of irradiated mixed oxide fuel from Capsule Nu-18 is given. (J.C.W.)

49773 (REIC-ACCESS-111) RADIATION EFFECTS INFORMATION CENTER QUARTERLY ACCESSION LIST. Abstract No. 36231-36276, October 1, 1967–October 31, 1967. (Battelle Memorial Inst., Columbus, Ohio. Radiation Effects Information Center). Nov. 10, 1967. 20p.

Forty-six abstracts are presented on the effects of nuclear radiation on metals, ceramics, chemicals, and electronics and the effects of space radiation on electronics and nonelectrical material. (R.C.K.)

49774 STABILIZED CAVITIES IN IRRADIATED AUSTENITIC STAINLESS STEEL. Brager, H. R.; Robbins, R. E. (Battelle Northwest Labs., Richland, Wash.). Contract AT(45-1)-1830. Trans. Met. Soc. AIME, 242: 2010-11(Sept. 1968).

The results are discussed of cavities produced in commercial type 304 stainless steel irradiated in the ETR at 290°C to a high neutron fluence, 6×10^{21} n per cm^2. The unusual result is that the calculated quantity of helium gas produced by transmutation during

the irradiation, 12 ppM, is less than one-tenth the amount of gas, necessary to balance the surface tension of the observed cavities produced in the steel during ETR irradiation. (J.C.W.)

49775 CORRELATION OF TENSILE AND FATIGUE PROPERTIES OF IRRADIATED TYPE 347 STAINLESS STEEL AT ROOM TEMPERATURE. Kangilaski, M.; Shober, F. R. (Battelle Memorial Inst., Columbus, Ohio). Nucl. Appl., 5: 283-5(1968).

Predictions of the room temperature fatigue life of type 347 stainless steel, irradiated to 5.5×10^{21} and 11×10^{21} n/cm^2, were made from tensile tests and the use of Manson's relationship. It was found that the total strain vs cycles-to-failure for irradiated type 347 stainless steel can be predicted reasonably well for total strains of 1 to 2% at both levels of irradiation. However, the predicted fatigue lives were conservative for total strains that are <1% for material irradiated to a fast fluence of 11×10^{21} n/cm^2. Not enough experimental data points were available to correlate the measured fatigue life with predicted fatigue life at total strains of <1% for stainless steel irradiated to a fast fluence of 5.5×10^{21} n/cm^2. (auth)

49776 NEUTRON IRRADIATION EXPERIMENTS AT 78°K ON Al AND Al ALLOYS. Pieragostini, Federico (SORIN, Saluggia, Italy). pp 829-38 of Fisica del Reattore. Rome, Consiglio Nazionale delle Ricerche, 1966. (In Italian).

From Conference on Physics of Reactors, Milan. See CONF-469.

The liquid nitrogen cryostat, installed at the reactor Avogadro RS1 is described, which serves mainly for irradiations of solids at low temperature. Results of a research work are reviewed, which have been performed in collaboration with the ISML of Novara, concerning the effects of neutron irradiation at 78°K on pure Al 99.995% and on various binary Al alloys. (auth)

49777 THEORY OF SWELLING. August, M. (Zentralinstitut fuer Kernforschung, Dresden). Kernenergie, 11: 186-90(July 1968). (In German).

In the swelling model of Barnes it is supposed that there are always bubbles of equal size only. In this paper the limiting assumption is dropped and a description is given taking into account the bubble spectrum. For the bubble distribution function a nonlinear integro-differential equation is derived, which is transformed into an infinite system of ordinary differential equations. For the solution of the system of differential equations by numerical integration, an analytical representation can be found. The expression for the asymptotic time behavior of the isothermal postirradiation swelling given by Barnes is verified. (auth)

49778 STUDIES OF THE SWELLING OF URANIUM UNDER IRRADIATION. Lehmann, J.; Paoli, P.; Azam, N. (Centre d'Etudes Nucleaires, Saclay, France). J. Nucl. Mater., 27: 285-309(Sept. 1968). (In French).

Swelling under irradiation of small samples of uranium alloys was studied at controlled temperatures and pressures. Preliminary results for the following alloys are presented: Sicral F1, Sicral F2, U-Mo 1,1 and U-Mo-Al-Sn. The amount of swelling as determined from density measurements showed a sharply defined maximum between 450 and 550°C, from the beginning of irradiation up to a dose of 500 MWd/t. A hydrostatic pressure of 40 bar greatly reduces swelling, by a factor of 2-4 according to the alloy. This effect is particularly pronounced for U-Mo-Al-Sn. The maximum swelling is due to the internal stress system brought about by the anisotropic growth of the grains. A tentative explanation of the relevant mechanism is advanced. It is based essentially on electron-micrographic observations: homogeneous nucleation of gas bubbles on the metal and growth of the bubbles by vacancy diffusion in the interior of grains in a state of internal tension. (auth)

Ceramics and Cermets

Refer also to abstracts 49679 and 49680.

49779 CERAMIC-TO-METAL BONDING. Helgesson, Claes I. Cambridge, Mass., Boston Technical Publishers, Inc., 1968. 121p. $14.50.

The technically useful combinations of metals and ceramics, including dispersion strengthened metals, metal fiber reinforced ceramics, ceramic fiber reinforced metals, cermets, ceramic coatings on metals, and metal coatings on ceramics are discussed. A review of currently applied methods of ceramic-to-metal seals is presented. From tests on the ceramic adherence qualities of 50 metallizing mixtures, a bonding mechanism for metal-to-ceramic seals is proposed based on metallographic microscope examination, electron probe microanalysis, and x-ray diffraction studies. (D.H.M.)

49780 FABRICATION OF CERAMIC TYPE POWER REACTOR FUEL ELEMENTS. VIII NUCLEAR CONGRESS, ROME, 19-20 JUNE 1963. Roma, Comitato Nazionale Energia Nucleare, 1967. 475p. (In Several Languages). (CONF-193-(Vol.1)).

Twenty-three papers were presented at the conference. A separate abstract was prepared for each paper. (J.R.D.)

For abstracts of individual papers see: 48992, 49694, 49730, 49788-49790, 49793-49800, 49821, 49822, 49828, 49844, 49859-49861, 50750, and 50751.

Corrosion and Erosion

49781 OXIDATION OF TITANIUM DIBORIDE AND ZIRCONIUM DIBORIDE AT HIGH TEMPERATURES. Irving, R. J.; Worsley, I. G. (Univ. of Surrey, London). J. Less-Common Metals, 16: 103-12(Oct. 1968).

Powdered and compacted TiB_2 have been heated in oxygen at pressures of 760 to 200 mm Hg. The TiB_2-O_2 reaction rate is parabolic except near 950°C where it is cubic. The activation energy below 950°C is 45 kcal/mole and above 950°C is 31 kcal/mole. The ZrB_2-O_2 reaction rate is parabolic throughout the range 700 to 1050°C and the activation energy is 28 kcal/mole. With both TiB_2 and ZrB_2 there is a minimum rate of reaction at about 600 mm pressure. The variation of oxidation rate with temperature and pressure is discussed in terms of a protective but volatile layer of B_2O_3. (auth)

49782 EFFECT OF HIGH-TEMPERATURE GAS CURRENT ON REFRACTORIES OF ZIRCONIUM DIOXIDE. Mayauskas, I. S. (Inst. of Physical-Technical Problems of Energy, Vilnyus, USSR); Abraitis, R. I.; Karaulov, A. G.; Grebenyuk, A. A. Ogneupory, No. 6, 45-50(June 1968). (In Russian).

The results of the corrosion and erosion stability tests on dense and porous samples of zirconium dioxide in high-temperature gas currents are reported. The erosion rate increased with increase of the temperature, the flow rate, and with the introduction of alkaline additions to the combustion products. The erosion rate depends on the chemical composition and structure of the sample and is most substantial in the first hour under the influence of the gas current. (tr-auth)

49783 HARDENING MECHANISMS IN LiF, NaF, AND CaF_2 BY SURFACE CONTAMINATION AND γ IRRADIATION. Sashital, Sanatkumar Ramanath. University Park, Pa., Pennsylvania State Univ., 1967. 157p.

Thesis.

The effect of surface contamination by the ambient atmosphere on the ductility, microhardness, and dislocation mobility of LiF, NaF, and CaF_2 single crystals has been studied. On exposure to atmospheric air, freshly cleaved surfaces of these crystals undergo embrittlement, hardening, and a reduction in the mobility of dislocations. The present investigations have established that these effects arise out of contamination of the surface layers by atmospheric oxygen. The observed changes in the above mentioned mechanical properties were also found to be dependent on the density and distribution of dislocation half loops on the cleaved surfaces prior to testing. It is believed that the oxygen molecules adsorbed on the surface get ionized into O^{2-} ions at the sites of emergence of edge dislocations and diffuse into the surface layers by the dislocation pipe diffusion mechanism. It is further proposed that these O^{2-} ions form defect complexes with the charge compensating F^- ion vacancies. Such defect complexes on account of their asymmetric strain fields and consequent strong interaction with mobile dislocations are responsible for the observed hardening effects. Irradiation of pure CaF_2 crystals by γ-rays gives rise to four color center absorption peaks at 580 mμ, 400 mμ, 335 mμ, and 225 mμ. A study of the variation of the flow stress, microhardness and dislocation mobility in CaF_2 crystals, irradiated up to 2.5×10^8 r γ-rays, has indicated that in the high dosage region the changes in the mechanical properties correlate well with the increase in the concentration of the color center with its absorption peak at 335 mμ. The observed rapid hardening at high dosage levels (above 7.5×10^7 r) has suggested that the 335 mμ absorption peak may be due to a color center defect with an asymmetric strain field. The experimental observations have indicated that this may be a color center of the V_k type produced by the formation of F_2^--molecular ions. (Disser. Abstr.)

Preparation and Fabrication

Refer also to abstracts 49837, 50750, 50751, and 50841.

49784 (LA-3901) ESTIMATION OF OPTIMUM BINDER CONCENTRATION FOR MOLDED CARBONS. Imprescia, R. J. (Los Alamos Scientific Lab., N. Mex.). Feb. 1968. Contract W-7405-eng-36. 11p. Dep. CFSTI.

The optimum binder concentration of a given filler-binder system is usually determined by measuring properties of fabricated carbons as a function of binder content. This technique is necessarily lengthy and expensive. Two other methods are described for estimating the binder optimum, both of which are based on the determination of the void volume within the network of the compacted filler. The first of these makes use of a simple relation for calculating an apparent void volume from measurements on a hot-molded, pitch-bonded carbon. In the second method, a highly volatile lubricant is substituted for the binder in the mix and, by the weight loss on evaporation of the lubricant, an equivalent volume is calculated. The optima estimated by these two techniques agree well with those determined by the direct measurement of properties. (auth)

49785 (LA-DC-9686) SOLID SOLUTION OXIDE FUELS FOR SPACE ELECTRIC POWER HEAT SYSTEMS. Leary, J. A. (Los Alamos Scientific Lab., N. Mex.). [nd]. Contract W-7405-eng-36. 8p. (CONF-680626-1). Dep. CFSTI.

From Potential Contractors Conference on NAVSAT, Albuquerque, N. Mex.

A brief review of progress in the development of solid solution oxide fuel disks for power systems in space vehicles is presented. Phases discussed include crystallographic structure, preparation from powders, chemical composition, compatibility, power densities, and physical properties. (P.G.C.)

49786 GROWTH OF TUNGSTEN CARBIDE MONOCRYSTALS. Gerk, A. P.; Gilman, J. J. (Univ. of Illinois, Urbana). J. Appl. Phys., 39: 4497-4500(Sept. 1968).

Tungsten carbide monocrystals have been grown from a Co flux using a modified Czochralski technique. These crystals are about 1 cm in size, show little internal strain, and contain few Co inclusions. The highest-quality crystals grow in the [0001] direction with a melt composition of 16 mole % WC–84 mole % Co, a surface temperature of 1475°C, and a pulling rate of 0.2 mm/hr. (auth)

49787 PRODUCTION OF URANIUM MONOCARBIDE. (to North American Aviation, Inc.). British Patent 1,127,041. Sept. 11, 1968. Priority date Oct. 2, 1964, United States.

A method for producing UC directly from UF_4 comprises contracting the UF_4, SiO_2, and C at a temperature of at least 400°C under an inert gas or vacuum environment until evolution of the resulting SiF_4 gas is complete and then increasing the temperature to at least 1300°C and maintaining this temperature until the formation of UC is complete. (B.L.M.)

49788 PREPARATION OF THORIUM DICARBIDE AND URANIUM–THORIUM DICARBIDE SPHERES BY A SOL-GEL PROCESS. Kelly, J. L.; Dean, O. C.; Kleinsteuber, Á. T. (Oak Ridge National Lab., Tenn.). pp 369-76 of Fabrication of Ceramic Type Power Reactor Fuel Elements. VIII Nuclear Congress, Rome, 19–20 June 1963. Roma, Comitato Nazionale Energia Nucleare, 1967.

See CONF-193–(Vol.1).

The sol-gel process for preparing spheres of ThC_2 and of thorium-uranium dicarbides for advanced gas-cooled reactor fuels is described. (P.G.C.)

49789 COATED PARTICLE CERAMIC FUEL FOR THE DRAGON REACTOR. Huddle, R. A. U. pp 377-96 of Fabrication of Ceramic Type Power Reactor Fuel Elements. VIII Nuclear Congress, Rome, 19–20 June 1963. Roma, Comitato Nazionale Energia Nucleare, 1967.

See CONF-193–(Vol.1).

Methods for preparation of fission product retaining carbon coated fuel particles for the Dragon Reactor are described. Information is given on preparation of the powdered ingredients, granulation, sizing, spheroidizing, and sintering of UC–ZrC, and UC–Th–C fuel pellets, and on procedures for coating with pyrocarbon. The prototype production scale fluidized bed used for coating the fuel spheres is illustrated. (P.G.C.)

49790 EVOLUTION OF THE PRODUCTION PROCEDURES FOR URANIUM CARBIDE FUELS. Porneuf, A.; Hauser, R. (Compagnie Industrielle des Combustibles Atomiques Frittes, Orsay, France). pp 397-413 of Fabrication of Ceramic Type Power Reactor Fuel Elements. VIII Nuclear Congress, Rome, 19–20 June 1963. Roma, Comitato Nazionale Energia Nucleare, 1967. (In French).

See CONF-193–(Vol.1).

A brief review is given of laboratory scale methods for the arc-furnace melting and casting of uranium carbides. The method is based on a technique which uses, without modification, commercial arc furnaces and completely automates the casting with no mechanical control devices. The apparatus and techniques are described in detail. Its application to the industrial fabrication of 2 tons of high density uranium carbide rods is outlined. In this industrial method the casting and molding of the uranium carbide takes place within the arc-furnace itself. The casting is done automatically when all the material is melted without interruption of heating. No auxiliary preheating of the molds is necessary. (J.S.R.)

49791 SOME PROBLEMS OF THE PRODUCTION AND FABRICATION ECONOMICS OF SINTERED UO_2. Ristic, M. M. Interceram (Luebeck, Ger.), 16: 139-40(July 1967).

Further development of nuclear energy plants requires the production of good quality sintered UO_2. There is an interdependence of technological possibilities and performances of sintered UO_2. (auth)

49792 IMPROVEMENTS RELATING TO METHODS OF PRODUCING ALUMINA FILMS. (to Philips Electronic and Associated Industries Ltd.). British Patent 1,121,241. July 24, 1968. Priority date Jan. 27, 1966, Netherlands.

A method is given of forming a porous aluminum oxide frame from 5 to 20 μ thick on one side of an aluminum foil by anodic oxidation. Then the aluminum oxide film is formed on the same side by anodic oxidation of the foil enclosed by the frame so that the film and the frame are integral. Then the remaining metallic aluminum is removed with the aid of a reagent which dissolves aluminum but does not attack the aluminum oxide. (J.C.W.)

49793 ADAPTATION OF UO_2 CERAMIC PROCESSES TO POWDERS OF VARIOUS CHARACTERISTICS. Harrington, C. D. (United Nuclear Corp., St. Louis). pp 47-69 of Fabrication of Ceramic Type Power Reactor Fuel Elements. VIII Nuclear Congress, Rome, 19–20 June 1963. Roma, Comitato Nazionale Energia Nucleare, 1967.

See CONF-193–(Vol.1).

Commercial methods for production of dense and uniform fuel pellets from UO_2 powders of widely differing characteristics are described. The physical properties of "dense" and "fluffy" UO_2 powders, as they affect compacting and sintering, are itemized. Problems involved in agglomeration, lubrication, de-waxing, compacting, and sintering are discussed. A pellet production flow sheet is shown. (P.G.C.)

49794 SINTERING IN CARBON DIOXIDE OF URANIUM DIOXIDE. Amato, I.; Colombo, R.; Protti, A. (Fiat, Turin). pp 71-81 of Fabrication of Ceramic Type Power Reactor Fuel Elements. VIII Nuclear Congress, Rome, 19–20 June 1963. Roma, Comitato Nazionale Energia Nucleare, 1967. (In Italian).

See CONF-193–(Vol.1).

Uranium dioxide used as a fuel in pressurized water reactors and boiling water reactors is prepared by powder metallurgical methods, usually in hydrogen and dissociated ammonium atmosphere. The substitution of carbon dioxide for the hydrogen during the high temperature compaction is proposed. The heating process can be carried out in nitrogen or in carbon dioxide but the first part of the refining should be made in hydrogen in order to reduce the higher oxide of uranium and to assure the stoichiometry of the final product. Experimental studies carried out to determine the properties of uranium dioxide compacts made under these conditions are described. Micrographic examinations were made of the final product. The results showed that the same density is obtainable in carbon dioxide at a temperature lower, by about 350°C, than that necessary in hydrogen. The distribution of porosity is basically analogous to that of compacts made using the same type powder and sintered in hydrogen. Typical micrographs are given. The dissociation of carbon dioxide into oxygen and into carbon monoxide is discussed. (J.S.R.)

49795 EVOLUTION OF THE INDUSTRIAL PROCEDURES FOR THE SHAPING AND FRITTING OF URANIUM OXIDE. Hauser, R.; Porneuf, A. (Compagnie Industrielle des Combustibles Atomiques Frittes, Orsay, France). pp 93-126 of Fabrication of Ceramic Type Power Reactor Fuel Elements. VIII Nuclear Congress, Rome, 19–20 June 1963. Roma, Comitato Nazionale Energia Nucleare, 1967. (In French).

See CONF-193–(Vol.1).

The specifications for industrial procedures used in shaping and sintering of uranium dioxide are defined. Methods of granulation and shaping were studied and compared. The sintering density from batch and continuous furnaces is compared. These studies and results led to the design, on the pilot scale, of a procedure for the shaping of uranium dioxide. The granulation tests led to the rejection of wet processing methods and to the adoption of dry granulation methods without binder. The double cycle compression procedure was shown to be of general application and promotes significant reductions in dispersions. The simple cycle procedure can be used only with certain UO_2 powders prepared in the rotating furnace. The dry granulation studies prompted the development of a test for the interpretation of differences in sinterability evident in UO_2 powders of the same

specific surface. A continuous sintering furnace is used in industrial production of UO_2 pellets with a density higher than 10.50 g/cm^3. The use of the continuous furnace is characterized by the great regularity of the characteristics of the sintered products. Sintering in a continuous furnace reduces the densification dispersion. (J.S.R.)

49796 A PILOT PLANT FOR THE PRODUCTION OF Th-^{233}U RECYCLE FUELS. Schileo, G.; Weissert, L. R. (Babcock and Wilcox Co., Lynchburg, Va.). pp 167-81 of Fabrication of Ceramic Type Power Reactor Fuel Elements. VIII Nuclear Congress, Rome, 19–20 June 1963. Roma, Comitato Nazionale Energia Nucleare, 1967.

See CONF-193-(Vol.1).

A pilot-plant facility for recycling Th-^{233}U fuels for the Spectral Shift Control Reactor is described. Flowsheets are shown for refabrication of fuel by the sol-gel process, fuel material preparation, fuel-rod fabrication by vibratory compaction, and fuel element assembly, inspection, and storage. (P.G.C.)

49797 EXTRUSION OF MIXED OXIDE OF THORIUM AND URANIUM. Cogliati, G.; De Leone, R.; Ferrari, S.; Gabaglio, M.; Liscia, A. (CNEN, Rome). pp 151-66 of Fabrication of Ceramic Type Power Reactor Fuel Elements. VIII Nuclear Congress, Rome, 19–20 June 1963. Roma, Comitato Nazionale Energia Nucleare, 1967. (In Italian).

See CONF-193-(Vol.1).

The extrusion technique was tested on mixed oxides obtained by the coprecipitation of thorium oxalate and uranium oxalate. With this type of oxide it is possible to obtain cylinders having a final density of 97% of theoretical. The factors affecting the extrusion and sintering are the binders used, the dimensions of the particles of the powder, the wetness of the mass to be extruded, and the extrusion force. Each of these was studied. The method developed as a result of these studies is outlined. (J.S.R.)

49798 A NEW PROCESS FOR THE REMOTE PREPARATION AND FABRICATION OF FUEL ELEMENTS CONTAINING ^{233}U OXIDE–THORIUM OXIDE. Dean, O. C.; Brooksbank, R. E.; Lotts, A. L. (Oak Ridge National Lab., Tenn.). pp 127-50 of Fabrication of Ceramic Type Power Reactor Fuel Elements. VIII Nuclear Congress, Rome, 19–20 June 1963. Roma, Comitato Nazionale Energia Nucleare, 1967.

See CONF-193-(Vol.1).

Design, development, and operational performance of a remote or semi-remote controlled pilot plant for processing and handling $^{233}U-ThO_2$ fuel elements are described. Information is given on solvent purification of ^{233}U, sol-gel preparation of UO_2, fabrication of Zircaloy-2 clad rods, end-cap welding, radiation safety, and decontamination procedures. Properties of the sol-gel material are tabulated and flow sheets and special equipment are illustrated. (P.G.C.)

49799 RECYCLE OF CERAMIC AND CERMET FUELS USING COLD BINDER EXTRUSION. Davidson, J. K.; Miller, R. S. pp 241-58 of Fabrication of Ceramic Type Power Reactor Fuel Elements. VIII Nuclear Congress, Rome, 19–20 June 1963. Roma, Comitato Nazionale Energia Nucleare, 1967.

See CONF-193-(Vol.1).

The processing and refabrication technology used in recycling fast breeder reactor fuels of mixed oxides of Pu, Th, or U is described. Cermet fuels, which permit immediate fast reactor operation, may be made by extrusion with a cold binder and the process may be adapted to the fabrication of cermet fuels consisting of fissile ceramic fuels dispersed in a Th metal matrix. Equipment used for extrusion, pellet loading, fuel element assembly, helium leak and weld testing is illustrated by line drawings. A flow sheet for a UO_2-Th recycle is shown. (P.G.C.)

49800 EXPERIMENTAL STUDIES ON PuO_2-UO_2 FUEL FOR FAST REACTORS. Alter, H. W.; Leitz, F. J. (General Electric Co., Pleasanton, Calif.). pp 227-39 of Fabrication of Ceramic Type Power Reactor Fuel Elements. VIII Nuclear Congress, Rome, 19–20 June 1963. Roma, Comitato Nazionale Energia Nucleare, 1967.

See CONF-193-(Vol.1).

Design, fabrication, testing, and evaluation of mixed PuO_2-UO_2 solid solution fuels for fast reactors are reviewed. Economic advantages of this fuel are compared with those of conventional fuels. (P.G.C.)

49801 PRODUCTION OF MICROSPHERES. (to W. R. Grace and Co.). British Patent 1,125,915. Sept. 5, 1968. Priority date Apr. 21, 1965, United States.

A process is given for forming microspheres of 50 to 400 microns by mixing an aquasol containing dissolved U^{4+}, $(UO_2)^{2+}$, Th^{4+}, Pu^{4+}, $(PuO_2)^{2+}$, $(ZrO)^{2+}$, Be^{2+}, or Y^{3+} salt or a mixture thereof, with an ammonia-releasing agent. Droplets are formed in a liquid medium in which water has low solubility and the temperature is sufficiently high enough that the agent provides substantial release of ammonia. The droplets are maintained in contact with the liquid medium, gel and have water extracted from them by the liquid medium and the droplets are solidified to microspheres. Seven manufacturing examples are given. (J.C.W.)

49802 PROCESS FOR THE MANUFACTURING OF NUCLEAR FUEL ELEMENTS. Mustacchi, Carlo; Gautsch, Othmar; Wahl, Hartmut (to EURATOM). British Patent 1,126,612. Sept. 11, 1968. Filed Feb. 9, 1965.

Expansion of carbide fuel elements, such as UC, is controlled by superficial oxidation of the fuel pellets, either with a gaseous or liquid oxidant, before the fuel can is closed. (P.G.C.)

49803 ASPECTS OF THE PREPARATION OF HIGH DENSITY CERAMIC OXIDE GRANULES. Garrett, K. H.; Records, F. A.; Stevenson, D. G. (Atomic Weapons Research Establishment, Aldermaston, Eng.). Chem. Eng. (London), No. 220, 216-22(July-Aug. 1968).

Processes employed in the nuclear energy field for the preparation of high density granules in the range of 10 μ up to a few millimetres diameter are reviewed. Gelation of colloidal and non-colloidal suspensions, aggregation of loose powders by tumbling or gyratory motion, mechanical compaction and crushing followed by spheroidisation, and fusion processes are discussed. Experience with a small gyratory spheroidising machine is discussed in detail. The behaviour of granules differs in a number of respects from conventional tumbling granulation, and high density spheres between 200 and 1500 μ diameter can be produced consistently. The effects of a number of factors on the process are described. (auth) (UK)

49804 NUCLEAR FUEL ELEMENT AND METHOD OF FABRICATING OF SAID ELEMENT. Bailly, Henri; Francois, Bernard; Meny, Lucienne (to Commissariat a l'Energie Atomique). British Patent 1,128,742. Oct. 2, 1968. Priority date Feb. 2, 1966, France.

Fuel elements composed of a ceramic material having an actinide base and contained in a can of zirconium or zirconium alloy are described. After compacting UO_2 powders, the pellets are coated with titanium nitride, niobium nitride, or a mixed nitride of titanium and niobium. The fuel elements are clad with zirconium or zirconium alloy. The three fabrication methods are described. (J.C.W.)

49805 INVESTIGATION OF THE SINTERING OF ZIRCONIUM DIOXIDE. Degtyareva, E. V.; Kainarskii, I. S.; Alekseenko, L. S. Ogneupory, No. 6, 33-40(June 1968). (In Russian).

The sintering of zirconium dioxide was investigated as a function of the activity of the primary materials. It was established that the sintering of zirconium dioxide proceeds by means of volumetric diffusion of vacancies. The effect of small additions of activated ZrO_2 and stabilizing additions was investigated. (tr-auth)

49806 PREPARATION AND CHARACTERIZATION OF METALLO-CERAMIC COMPOSITES, STAINLESS STEEL-URANIUM DIOXIDE. Amato, I.; Coselli, R. (FIAT, Turin). Met. Ital., 60: 155-8(Mar. 1968). (In Italian).

Cermet compounds, UO_2–AISI 347, have been obtained by vibratory compacting and hot isostatic pressing. The rod samples so, carried out, are formed by dispersion of UO_2 spheroids in an AISI 347 stainless steel matrix; a density of 94 to 96% of the theoretical value for these samples was obtained; a bonding between the stainless steel of the matrix and the stainless steel of rod canning was obtained. Measurements of thermal conductivity at low temperature showed that the samples of UO_2 dispersed in stainless steel matrix have a thermal conductivity very near the stainless steel values. (auth)

49807 PRINCIPAL METALLURGICAL CHARACTERISTICS OF FUEL ELEMENTS FABRICATED FOR Re-SuCo (OXIDE SUB-CRITICAL REACTOR). de Souza Santos, Tharcisio D. (Univ., Sao Paulo, Brazil); Haydt, Heliton M.; de Freitas, Clauer Trench; Trani Capocchi, Jose Deodoro; Leite Cintra, Sebastiao Hermano; Gentile, Erberto Francisco; Puccini, Ernesto Coutinho. Metalurgia (Sao Paulo), No. 143, 175-90(June 1967). (In Portuguese).

Data on the fabrication of Al clad UO_2 fuel elements for the RESUCO (Oxide Sub-Critical Reactor) at Sao Paulo, Brazil are presented. Included are descriptions of methods used to prepare the UO_2 by the ADU process, powder conditioning, compacting, presintering, fabrication and inspection of Al tubes, loading and closing the fuel elements, and final treatment of the assemblies. (P.G.C.)

49808 EXPERIMENTAL STUDIES ON THE PRODUCTION OF PELLETS OF ThO_2 AND ThO_2–UO_2. de Souza Santos, Tharcisio

D.; Haydt, Heliton M.; de Freitas, Clauer Trench; Trani Capocchi, Jose Deodoro; Puccini, Ernesto Coutinho (Instituto de Energia Atomica, Sao Paulo, Brazil). Metalurgia (Sao Paulo), No. 132, 883-8(Dec. 1966). (In Portuguese).

Experimental studies on the production of ThO_2 pellets as well as solid solutions of ThO_2 containing 1, 2, and 5% UO_2 are described. The ThO_2 and U_3O_8 powders were prepared, respectively, by dissociation of the $Th(SO_4)_2 \cdot 9H_2O$ and of ammonium diuranate, which contained variable percentages of sulfate. Owing to the low intrinsic compactibility of the obtained ThO_2, its behavior in prepressing was studied, from which it was determined that the best conditions were 1 ton/cm^2, the grain size of the powder not being important. The pressing and sintering properties were studied at different pressures, in a tubular muffle furnace at 1400°C for 1,3 and 9 hours. Data obtained showed that at 3 tons/cm^2 the time effect had no influence and that at 1 ton/cm^2 the increase in sintering rate was reasonably high. Comparative sintering tests on ThO_2 pellets in 10^{-5} mm of mercury vacuum showed results equal to those obtained in argon. (auth)

49809 CRYSTALLITE GROWTH OF BERYLLIUM OXIDE POWDERS AND ITS INHIBITION BY ADSORBED PHOSPHATE. Price, G. H.; Stuart, W. I.; Walker, D. G. (Australian Atomic Energy Commission Research Establishment, Lucas Heights). J. Amer. Ceram. Soc., 51: 481-4(Sept. 21, 1968).

Low-temperature sintering of beryllium oxide powders at 300 to 1000°C was studied by measuring crystallite growth and changes in specific surface. Sintering is enhanced by the presence of water vapor. Adsorbed phosphate almost completely inhibits sintering up to 850°C, even in water vapor at 10 torr. (auth)

49810 METHOD FOR SHAPING URANIUM OXIDE MOLDINGS. Nishijima, Toraji (to Tokyo Shibaura Electric Co., Ltd.). Japanese Patent 1968-3712. Feb. 10, 1968. Filed Mar. 16, 1965.

By the method proposed, utilizing plastic creep deformation of uranium oxide at high temperatures, the molding can take any shape easily, for example, from a straight one to a L-shaped one. To obtain a desired shape, an external force of less than 200 kg/cm^2 is applied suitably to the uranium oxide molding heated at 1500 to 2500°C. (NSA of Japan)

49811 GROWTH AND PROPERTIES OF $K_4Nb_6O_{17}$. Loiacono, G. M.; Michelman, B. (Isomet Corp., Palisades Park, N. J.). J. Amer. Ceram. Soc., 51: 542-3(Sept. 21, 1968).

Single crystals of $K_4Nb_6O_{17}$, K_3NbO_4, and K_3TaO_4 were grown by the Czochralski technique. The crystals of K_3NbO_4 and K_3TaO_4 cracked on cooling at 500 and 900°C, respectively. The $K_4Nb_6O_{17}$ crystal was examined and found to be biaxial and orthorhombic in structure. The density, dielectric constant, and hardness were measured. Volume expansion was noted on immersion in water at 80°C for 5 min. Water was found to be adsorbed and diffused parallel to the cleavage planes. Experiments eliminated the possibility of hydrate formation. (F.S.)

49812 FLUX GROWTH OF TYPE RVO_4 RARE-EARTH VANADATE CRYSTALS. Feigelson, Robert (Stanford Univ., Calif.). J. Amer. Ceram. Soc., 51: 538-9(Sept. 21, 1968).

Single crystals of rare earth vanadates were produced by adding a rare earth oxide to reagent grade PbO and V_2O_5. The crystal structures of the rare earth vanadates were confirmed by x-ray analysis. Vanadates of praseodymium through lutetium and yttrium have a prismatic morphology. Lanthanum vanadate formed plate like crystals of poor quality. Cerium vanadate crystals which are soluble in the HNO_3 leaching solution are lathlike or prismatic and are dark gray to black. Crystals of $LaVO_4$, $PrVO_4$, and $NdVO_3$ partially dissolved in dilute HNO_3. (F.S.)

49813 ISOSTATIC HOT PRESSING, A NEW TECHNIQUE IN POWDER METALLURGY. Bumm, H.; Thuemmler, F.; Weimar, P. (Kernforschungszentrums, Karlsruhe, Ger.). Ber. Deut. Keram. Ges., 45: 406-12(Aug. 1968). (In German).

The isostatic hot pressing technique for use in powder metallurgy is described. The process takes place in an autoclave at high temperatures and pressures. The specimen is placed in a metal container. The latter is capable of transferring the isostatic gas pressure, exerted on it, to the powder which thus attains a very high density. An apparatus has been developed, built and tried out: it is suitable for temperatures up to 1600°C and pressures of 1000 atm. Some physical properties of specimens produced by the method were determined and the values compared with those from the literature. (auth)

49814 METHOD OF PREPARING A CERMET NUCLEAR FUEL. Burgess, Carl A. (to United States Atomic Energy Commission). U. S. Patent 3,404,200. Oct. 1, 1968.

A method of preparing a cermet nuclear fuel comprising preparing rounded particles of stoichiometric plutonium dioxide or uranium dioxide or mixtures thereof having a density substantially less than theoretical is described. The particles are mixed with metal particles, compressed into pellets, loaded into heavy cans, and the can and contents are coextruded. (AEC)

Properties Evaluations

Refer also to abstracts 49740, 49744, 49846, 50731, and 50841.

49815 (AECL–3069) CARBON, GRAPHITE, AND SOME CARBIDES FOR SUPERHEAT SERVICE: LITERATURE SURVEY. Peggs, I. D. (Atomic Energy of Canada Ltd., Pinawa (Manitoba). Whiteshell Nuclear Research Establishment). Mar. 1968. 75p. Dep. CFSTI. CAN $2.00.

A literature survey was carried out on carbon based materials with particular reference to their application as constructional materials in a superheated-steam-cooled reactor core. The properties of graphites, carbides and carbons were considered together with the effects on them of steam and irradiation. It is concluded that present electrographites do not meet the requirements for this application without improvements in such properties as fracture toughness and oxidation-resistance. Of the carbides, silicon carbide appears to be the most promising material but suffers from many of the same problems as graphite. Radiation damage to silicon carbide is relatively small and what damage there is saturates quickly at low doses; hence dimensional stability is very good. Pyrocarbon and the more recent glassy and cellulose carbons hold considerable promise but fracture toughness is still one of their dominant problems. (auth)

49816 (COO–1122-14) RECRYSTALLIZATION AND SINTERING OF OXIDES. Technical Progress Report, September 1, 1967–August 31, 1968. [Cutler, Ivan B.] (Utah Univ., Salt Lake City. Coll. of Engineering). Contract AT(11-1)-1122. 7p. (UTEC–68-068). Dep. CFSTI.

Five abstracts are presented on research performed. Effect of particle shape on the kinetics of sintering of glass, the effect of water vapor on the sintering of glass powder compacts, sintering of glass powders during constant rates of heating, and determination of an effective viscosity of powders as a function of temperature are listed. Progress on the interdiffusion studies of transition metal oxides in MgO is reported. (J.C.W.)

49817 (EURAEC–2036) USE OF PLUTONIUM AS NUCLEAR REACTOR FUEL. Quarterly Report No. 17, January 1–March 31, 1968. (Centre d'Etude de l'Energie Nucleaire, Brussels (Belgium)). Apr. 1968. Contract 001-64-1-TRUB. 70p. (EUR–3986; BN–6804-01). Dep. CFSTI.

Work Performed under United States–Euratom Joint Research and Development Program.

Fabrication of the 260 homogeneous fuel rods containing 2% ^{235}U and 2.7% ^{239}Pu is completed. Fabrication has started on the making of 250 heterogeneous type rods containing 2% ^{235}U and 2.7% ^{239}Pu. A part of these rods will be fabricated in the self-contained unit on the pneumatic vibrator. Checking of the chlorine content of the plutoniferous rods has continued satisfactorily. Two checking procedures of the density measurements with mercury and the determination of the humidity content of solid samples have been established. A new series of eight trip burnouts has been carried out in the burnout testing. The results on fuel assessment of the dimensional measurements and the tapping tests are given for the six rods irradiated in hydraulic conveyor (HR-1 runs 5 and 6). The swelling of the rods reached several per cent and there is a difference between the homogeneous and heterogeneous rods in composition and volume of gas collected. Two irradiation tests of three Zircaloy 2 clad fuel rods have been effected in hydraulic conveyor at a power rate in the region of 770 W/cm (HR-1 runs 9 and 10). Following the 9 and 10 HR-1 runs, three sets of three stainless steel clad fuel rods were irradiated up to a power of 1250 W/cm. The dimensional measurements effected before and after irradiation showed that the homogeneous rods had swollen by about 1 to 2%, while the heterogeneous rods had retained their initial dimensions. The maximum power attained in CEB-4 is 800 W/cm. The burn-up ratios are 22500 MWd/t in the homogeneous rod and 18500 MWd/t in the heterogeneous rod. The PANTHER code has been improved by proceeding with the treatment of the heterogeneity in the fast field, the broadening of the resonance of ^{240}Pu at 1.05 eV with the temperature, and modifications in the fast library of some isotopes. The rectangular configuration with a 1.303 cm square pitch has been studied with 4/0 fuel. The critical mass has been determined, together with the axial and radial bucklings. The reactive effects and the power distributions have been measured in the presence of a number of perturbations (water films, aluminum plate, absorbent rods). Analysis of the data from the sub-critical VENUS-Vulcain tests has continued. A supplementary program of sub-critical tests on 4/0 fuel with an $N\sqrt{2}$

pitch has been outlined. The study of the power distribution during the 5th cycle has been undertaken in the case where the 7th core layer contains a UO_2-PuO_2 area with 3.6 wt % of PuO_2. (J.C.W.)

49818 (ORNL–4300) VAPOR PRESSURE OF TELLURIUM DIOXIDE. Malinauskas, A. P. (Oak Ridge National Lab., Tenn.). Sept. 1968. Contract W-7405-eng-26. 19p. Dep. CFSTI.

Results of a survey of the literature on the determination of the vapor pressure of tellurium dioxide are presented. Data are reported as derived from the mass transport method and the Knudsen effusion technique, and an attempt is made to utilize the results of the two methods to assess the extent of dimer formation in the gas phase. Until a more definitive assessment of polymer formation can be made, it is proposed that the expression $\log_{10} p(\text{torr}) = 12.3487 - (13.238 \times 10^3)/T$ be employed for the calculation of the vapor pressure of TeO_2 over the solid in the temperature range $700°K < T < 1000°K$. From this expression the heat of sublimation is calculated to be 60.58 ± 0.33 kcal/mole. (auth)

49819 HEATS OF TRANSITION IN $NaNbO_3$. Tennery, Victor J.; Hang, Kenneth W. (Univ. of Illinois, Urbana). J. Amer. Ceram. Soc., 51: 469(Aug. 21, 1968).

Calorimetric methods were used to measure the entropy and enthalpy changes in sodium niobate at temperatures from 372 to 640°C. (P.G.C.)

49820 GAS EVOLUTION IN NON-FISSILE IRRADIATED CERAMICS. Scott, K. T.; Wassel, L. L. (United Kingdom Atomic Energy Authority, Harwell, Eng.). Bull. Soc. Fr. Ceram., No. 77, 15-26(Oct.-Dec. 1967). (In French).

Neutron irradiation of powders and crystals of BeO at low temperatures produces T in a condensable (presumably T_2O) and a noncondensable (T_2) form. After heating as the first reaction to irradiation, the sample undergoes a "puff" followed by release of gas resembling a diffusion-controlled process. At low temperatures the release with "puffing" predominates, but carries only small amounts of the total T content. At higher temperatures, the processes are similar but a much greater fraction of the total T content is released. Diffusion release is controlled by the dose, the diffusion coefficient rising with the dose at all temperatures. The values are analogous to those for the autodiffusion of the O ion; perhaps T is moving as OT ions. No conclusions were obtained about the amount of T occurring as T_2O since the amount varied irregularly. In the irradiation of MgO monocrystals, He and Ne were found to remain in the material even after baking at a high temperature. These gases accumulate in faults and cavities. (BBB)

49821 CHARACTERIZATION OF URANIUM POWDERS WITH RESPECT TO THE PREPARATION OF FRITTABLE DIOXIDE. Holder, J.; Braun, C. pp 307-21 of Fabrication of Ceramic Type Power Reactor Fuel Elements. VIII Nuclear Congress, Rome, 19–20 June 1963. Roma, Comitato Nazionale Energia Nucleare, 1967. (In French).

See CONF-193-(Vol.1).

Tests were made to establish a correlation between some physico-chemical measurements made on the primary materials chosen (ammonium uranate), the intermediate oxide or the powder oxide, and the sintering behavior of this dioxide under standard conditions of 6 hrs at 1650°C in hydrogen. The studies showed the evolution of the physical characteristics of the uranium oxides beginning with the primary material, ammonium uranate, as a function of the calcination and reduction operations carried out continuously on a semi-industrial scale. Of the characterization method used, the measurement of the mean diameter of the UO_2 grain with the Blaine permeability device is the most significant because it can be connected very clearly with the sintering capacity of the dioxide powder. This sintering capacity can be improved, in the case of fine oxides (diameter = 0.5 μ), by carrying out the calcination or reduction at definite temperatures. (J.S.R.)

49822 CRITERIA FOR THE DESIGN OF A FUEL ELEMENT OF THE CERAMIC TYPE FOR POWER REACTORS. Di Menza, R.; Pierazzi, L. pp 333-42 of Fabrication of Ceramic Type Power Reactor Fuel Elements. VIII Nuclear Congress, Rome, 19–20 June 1963. Roma, Comitato Nazionale Energia Nucleare, 1967. (In Italian).

See CONF-193-(Vol.1).

Desirable characteristics of a power reactor core cooled and moderated using organic liquid, are compared with those of the Piqua reactor. The discussion is limited to rod clusters containing tablets of uranium oxide or carbide clad in stainless steel, alloyed steel, zirconium, aluminum, and SAP. The advantages and disadvantages of each fuel is briefly outlined with emphasis on the SAP. (J.S.R.)

49823 COMPRESSIVE CREEP OF URANIUM CARBIDE. Stellrecht, D. E.; Farkas, M. S.; Moak, D. P. (Battelle Memorial Inst., Columbus, Ohio). Contract W-7405-eng-92. J. Amer. Ceram. Soc., 51: 455-8(Aug. 21, 1968).

The compressive creep rates of slightly hyperstoichiometric uranium carbide were determined in vacuum at 1200 to 1600°C and 3000 to 10,000 psi. The equation best describing the minimum creep rates of uranium carbide over this range is: $\dot{\epsilon} = 1.8 \times 10^{-6}\sigma^3 \exp(-90{,}000/RT)$. (auth)

49824 HIGH-TEMPERATURE CERMETS. II. WETTING AND FABRICATION. Manning, Charles R. Jr.; Stoops, Robert F. (North Carolina State Univ., Raleigh). J. Amer. Ceram. Soc., 51: 415-19(Aug. 21, 1968).

Wetting tests were performed with refractory metal-ceramic combinations selected on the basis of previous compatibility studies. Sessile drop contact angles between liquid Cr, V, Pt, Rh, Mo, and Mo–Re alloy and solid ThO_2, HfO_2, ZrO_2, HfC, TaC, and ZrC were measured at temperatures up to 2800°C in helium. Little wetting occurred between these metals and the refractory oxides, but Mo and the Mo–Re alloy did wet the refractory carbides. Microscopic examination of the metal-ceramic interfaces showed that HfC–Mo-40 wt % Re and ZrC–Mo-40 wt % Re had highly desirable wetting and solubility characteristics for making cermets. Specimens were fabricated from these two systems with 25 and 50 vol % metal by cold-pressing and sintering and by hot-pressing. The microstructures of these cermets consisted of small, uniformly dispersed carbide particles in Mo–Re matrixes. The hardnesses and transverse rupture strengths of these cermets indicate that they have considerable promise for high-temperature applications. (auth)

49825 HIGH-TEMPERATURE CERMETS. I. COMPATIBILITY. Manning, Charles R. Jr.; Stoops, Robert F. (North Carolina State Univ., Raleigh). J. Amer. Ceram. Soc., 51: 411-15 (Aug. 21, 1968).

The stability of refractory oxides (Y_2O_3-stabilized HfO_2 and ZrO_2, ThO_2, CeO_2), carbides (HfC, NbC, TaC, and ZrC), borides (NbB_2 and TaB_2) and HfN was determined in combination with the Groups VIA and VIIA refractory metals and combinations thereof. Thermodynamic calculations were made to predict stability up to 2500°K between the ceramic oxides and carbides in contact with Mo, Re, and W. Reaction studies were conducted between the ceramics and the Groups VIA and VIIA refractory metals in vacuum and in helium to 2750°C. The Mo-40 wt % Re, Re, and W were stable in contact with the carbides, nitrides, and oxides to 2450°C with two exceptions. These occurred when CeO_2 reacted with W at 1700°C and Mo-40 wt % Re reacted with WC. The Mo-40 wt % Re and Re also reacted with the NbB_2 and TaB_2 above 2200°C to form very hard single-phase compounds. (auth)

49826 MICROSTRUCTURE AND MECHANICAL BEHAVIOR OF CARBIDES. Hollox, Graham E. (Martin-Marietta Corp., Baltimore). Contracts DA-31-124-ARO-D-467; NASw-1290. Mater. Sci. Eng., 3: 121-37(Sept. 1968).

Plastic flow, dislocation structures, and effects of carbon-to-metal ratio of titanium carbides are discussed. The mechanical behavior of ZrC, HfC, VC, NbC, and TaC is summarized in the review. The effect of alloying additions on mechanical behavior of carbides is reviewed. The effect of boron on the structure and properties of TiC and VC is discussed. The more interpretable information from studies of single crystals rather than that from sintered polycrystalline materials is emphasized. A listing of 96 references is included. (J.C.W.)

49827 PRODUCTION OF MICROSPHERES. (to W. R. Grace and Co.). British Patent 1,125,178. Aug. 28, 1968. Priority date Apr. 15, 1965, United States.

The production method of microspheres of actinide oxides or in combination with other metal oxides and/or carbon from 50 to 200 microns is described. An aqueous solution of salt of U^{4+}, $(UO_2)^{2+}$, Th^{4+}, Pu^{4+}, $(PuO_2)^{2+}$, $(ZrO)^{2+}$, Be^{2+}, or Y^{3+} is mixed with an ammonia-releasing agent in an amount of the agent at least sufficient to provide 70% of the stoichiometric quantity of ammonia required to precipitate the dissolved salt. Droplets of the mixture are formed in a liquid medium in which water has low solubility and whose temperature is sufficiently high that the agent provides substantial release of ammonia. The droplets are then maintained in contact with the liquid medium. The droplets gel and water is extracted by the liquid medium and are solidified to microspheres. Ten manufacturing examples are given. (J.C.W.)

49828 ESTABLISHING METHODS OF CHARACTERIZING UO_2 POWDER. Driear, J. R. (Westinghouse Atomic Fuel Dept., Cheswick, Pa.). pp 295-305 of Fabrication of Ceramic Type Power Reactor Fuel Elements. VIII Nuclear Congress, Rome, 19–20 June 1963. Roma, Comitato Nazionale Energia Nucleare, 1967.

See CONF-193-(Vol.1).

Methods used to determine physical characteristic such as specific surface area, particle size, shape, and soundness of UO_2 powders are described. (P.G.C.)

49829 MEASURING THE LOCAL ELECTRIC RESISTIVITY IN URANIUM DIOXIDE ROASTING. Sorriaux, A.; Rubio, A. (Centre d'Etudes Nucleaires, Saclay, France). Nucl. Instrum. Methods, 64: 233-4(Sept. 15, 1968). (In French).

A method is described for fission products diffusion profile determination in uranium dioxide samples by measuring the local electric resistivity with the four-point probe. (auth)

49830 DIRECTIONAL VARIATIONS OF ELASTIC PROPERTIES OF SOME TRANSITION METAL MONOCARBIDE CUBES. Brown, H. L.; Armstrong, P. E.; O'Rourke, J. A.; Kempter, C. P. (Los Alamos Scientific Lab., N. Mex.). Contract W-7405-eng-36. Planseeber. Pulvermet., 16: 114-18(July 1968). (LA-DC-9281).

The wave velocities which are used for elastic property calculations were determined at 23°C for monocarbides of Ti, Zr, Hf, Nb, Ta, and W. These data show the expected anisotropy to be found in die-pressed materials. Elastic moduli for ZrC, calculated from the data for isostatically pressed material, show good agreement with previously published data. (auth)

49831 DIFFUSION OF CARBON IN SINGLE CRYSTAL GRAPHITE. Feates, F. S. (Argonne National Lab., Ill. Atomic Energy Research Establishment, Harwell, Eng.). J. Nucl. Mater., 27: 325-30(Sept. 1968).

A method is described by which the etch decoration technique and electron microscopy are applied to the measurement of self-diffusion in graphite. Natural graphite single crystals have been labeled on their outer surfaces by a ^{14}CO exchange method. The ^{14}C was diffused into the crystals at 2000 to 2600°C, and they were set aside to allow a few ^{14}C atoms to decay to ^{14}N and thus create lattice vacancies. After cleaving the crystals, vacancies were expanded by oxidation and decorated with gold so that they could be counted. Self diffusion constants for diffusion parallel and perpendicular to the basal plane were 2.9×10^{-13} cm^2/sec and 2.5×10^{-14} cm^2/sec respectively at 2200°C. (auth)

49832 THERMAL CONDUCTIVITIES IN THE UO_2–SiO_2 SYSTEM IN THE TEMPERATURE RANGE 100 TO 800°C. Glanz, G. (Institut fuer Atomphysik, Bucharest). J. Nucl. Mater., 27: 331-4(Sept. 1968). (In German).

Thermal conductivities in the UO_2–SiO_2 system are reported for the temperature range 100 to 800°C, and empirical equations for thermal conductivity and thermal resistivity are reported. The mechanism of thermal conductivity in the quoted temperature range is principally determined by phonons. Observed values of thermal conductivity agree fairly well with values calculated on the basis of the two-phase model. (auth)

49833 RESISTOMETRIC STUDY OF THE SOLUTION AND PRECIPITATION OF HYDRIDES IN UNALLOYED ZIRCONIUM. Mishima, Y.; Ishino, S.; Nakajima, S. (Tokyo Univ.). J. Nucl. Mater., 27: 335-44(Sept. 1968).

A resistometric technique has been used to study the terminal solid solubility of hydrogen and the kinetics of hydride precipitation in α-zirconium. The terminal solid solubility of hydrogen in unalloyed zirconium is determined to be 65 to 70 ppM at 300°C. ΔH, the difference in partial molar heat of solution of hydrogen in the hydride and in α-phase zirconium, is found to be 10.8 kcal/mole. The resistivity increase is 1.9 ± 0.2 $\mu\Omega \cdot$cm per atomic percent of solute hydrogen. The rate of hydride precipitation is more rapid than reported earlier. In annealed specimens containing more than 100 ppM of hydrogen, obtaining a supersaturated solid solution by quenching into ice water is almost impossible, whereas in annealed materials containing less than 20 ppM of hydrogen, it is possible to get the solid solution state by quenching from about 300°C into ice water. However, in cold worked specimens, this is again impossible. An activation energy of 7.6 kcal/mole is obtained for hydride precipitation in α-zirconium at aging temperatures of 14 to −35°C. The reaction rate for hydride precipitation is nearly of the first order in the temperature range 14 to −35°C, and nearly of the second order in the range −50 to −67°C. (auth)

49834 ELEVATED TEMPERATURE COMPRESSIVE CREEP BEHAVIOR OF TUNGSTEN CARBIDE–COBALT ALLOYS. Smith, J. T.; Wood, J. D. (Lehigh Univ., Bethlehem, Pa.). Acta Met., 16: 1219-26(Oct. 1968).

The compressive creep deformation of two-phase tungsten carbide–cobalt alloys with 12 and 15% Co has been investigated at 800, 900, and 1000°C for stresses of 10,000 to 110,000 psi. At each temperature studied, the WC–Co alloys showed a decreasing steady-state creep rate with increasing WC particle size for low creep-stress levels. At high stress levels, the steady-state creep rate was observed to increase with increased WC particle size. These observations, with additional considerations of the creep behavior, indicated that two mechanisms were rate determining during deformation of WC–Co alloys. To ascertain the rate-determining mechanisms during deformation, existing creep models were extended to include the high volume loading of dispersed WC particles present in these alloys. At high stresses, the mechanism postulated to describe steady-state creep deformation was the looping of dislocations in the Co matrix between WC particles and the climb of pinched-off loops. The diffusion of Co in the matrix around WC particles has been suggested as the rate-controlling steady-state creep mechanism at low stresses. (auth)

49835 HEAT-RESISTANT COATINGS. A Symposium held in Leningrad, May 26-28, 1964. Toropov, N. A. (ed.). New York, Consultants Bureau, 1967. 172p. (NP-tr-1680; CONF-640533).

An abstract of this paper, prepared from the original language, appeared as NSA 21: 18333.

49836 DISCUSSION OF THERMAL PROPERTIES OF TANTALUM MONOCARBIDE AND TUNGSTEN MONOCARBIDE. Kempter, C. P.; Brown, H. L. (Los Alamos Scientific Lab., N. Mex.). Trans. Met. Soc. AIME, 242: 1751-7(Aug. 1968).

A criticism of terms used and calculated values for the mechanical properties of TaC and Wc used in Y. A. Chang's report "Thermal Properties of Tantalum Monocarbide and Tungsten Monocarbide" (previously abstracted as NSA 22: 11056) is followed by the author's reply. (P.G.C.)

49837 POROSITY DEPENDENCE OF YOUNG'S AND SHEAR MODULI OF POLYCRYSTALLINE YTTRIUM OXIDE. Manning, William R.; Hunter, Orville Jr. (Ames Lab., Iowa). J. Amer. Ceram. Soc., 51: 537-8(Sept. 21, 1968).

In an investigation of the elastic properties of rare earth oxides, polycrystalline Y_2O_3 was prepared by dry pressing yttria at 3000 psi with subsequent isostatic pressing at 50,000 psi and firing in graphite containers at 1800 to 2100°C. Bulk density was measured and porosity determined. Young's and shear moduli were determined by the sonic resonance method and presented as a function of porosity for comparison with previously determined values. (F.S.)

Structure and Phase Studies

Refer also to abstracts 48985, 49753, 49811, and 49812.

49838 (AWRE-O-43/68) USE OF SCANNING ELECTRON MICROSCOPY IN COMPOSITE MATERIALS RESEARCH. Calow, C. A.; Cooper, R. E. (Atomic Weapons Research Establishment, Aldermaston (England)). July 1968. 14p. Dep. CFSTI. UK 4s. 0d.

In recent years considerable interest has developed in the concept of composite materials, particularly of the type using strong fibres embedded in a weaker matrix, which can result in a material with unusually high strength and rigidity. Experimental work on suitable model systems has resulted in a good understanding of the principles governing the mechanical properties of such materials, but the production of practical materials still presents many problems. In particular, the use of whisker crystals, which exhibit extremely high strengths (10^6 psi) is difficult because of their small size—a few microns diameter and a few millimeters in length. The incorporation of fibres into a metal matrix is also difficult. A method is described which is being developed for producing composite materials consisting of aligned sapphire whiskers in a matrix of nickel. Scanning electron microscopy was used at a number of stages in this research and development. (auth) (UK)

49839 INVESTIGATION OF PHASE RELATIONSHIPS IN Ln_2O_3–Nb_2O_5 SYSTEMS IN REGIONS RICH IN NIOBIUM PENTOXIDE. Godina, N. A.; Savchenko, E. P.; Keler, E. K. Dokl. Akad. Nauk SSSR, 178: 1324-7(1968). (In Russian).

Phase relationships in the systems Ln_2O_3–Nb_2O_5 (where Ln = La, Ce, Pr, Nd) were studied in the Nb_2O_5-rich regions (Ln_2O_3 : Nb_2O_5 = 1 : 4 to 1 : 10). Solid phase reactions of mechanical mixtures of the oxides as well as coprecipitations from niobium pentachloride-rare earth element nitrate solution were examined. The oxides were calcined at 1000 to 1330°C and subjected to chemical and x-ray analysis. Reactions with Nd and La oxides were essentially complete after 2 hrs at 1100°. X-rays showed characteristic lines for the metaniobates $LnNbO_4$ and niobium pentoxide, the ratio changing depending on composition of the initial mixture. The compounds $Nd_2Nb_{12}O_{33}$ and $Pr_2Nb_{12}O_{33}$, obtainable by coprecipitation, cannot be synthesized by solid phase reaction from mechanical mixtures of the appropriate oxides because of their low thermal stability (decomposing at 1100 and 1200°, respec-

tively). $La_2Nb_{12}O_{33}$ and $Ce_2Nb_{12}O_{33}$ are stable at these temperatures and melt congruently. An approximate phase diagram was constructed for the system $Nd_2O_3-Nb_2O_5$. Examination of the electrical properties of $La_2Nb_{12}O_{33}$ showed the compound has high dielectric permeability ($\epsilon = 80$), hence it may be of interest in the radio ceramic industry. (ATD)

49840 BOND STRENGTH IN DIBORIDES OF SOME GROUP IV AND V METALS. Gillies, D. C.; Lewis, D. (Univ. of Surrey, London). J. Less-Common Metals, 16: 162-3(Oct. 1968).

Bond strengths on ball-milled titanium, niobium, and zirconium diborides are investigated. X ray line-broadening measurements and the Wagner method of profile analysis were made. Graphs of $\beta^2 \cos^2 \theta/\lambda^2$ against $4 \sin^2 \theta/\lambda^2$ are presented for the diborides. It is shown that TiB_2 and ZrB_2 are isotropic, while NbB_2 is anisotropic. Also shown is that strain induced in TiB_2 by ball-milling is less than ZrB_2 or NbB_2. (J.C.W.)

49841 STUDY OF THE FREE ENERGIES OF FORMATION OF URANIUM MONOCARBIDE AND URANIUM DICARBIDE. Craig, James A. (Gulf General Atomic, San Diego, Calif.); Balzhiser, Richard E.; Ragone, David V. Trans. Met. Soc. AIME, 242: 1809-13(Sept. 1968).

The Gibbs free energies of formation of UC_2 and UC were measured by equilibrating two-phase mixtures of UC_2 + C and UC_2 + UC with liquid bismuth. The measured equilibrium concentrations of uranium in the bismuth combined with available activity coefficient information yielded uranium activities in these two-phase regions. Measurements on UC_2 were performed over the range 1015 to 1160°K and on UC over the range 1115 to 1165°K. The values obtained for UC_2 are in excellent agreement with values determined using combustion calorimetry and low-temperature heat capacity measurements. The UC values are in fair agreement with the calorimetric values, differing by about 10% from the calorimetric determination. (auth)

49842 AN X-RAY STUDY OF THE CRYSTAL STRUCTURES OF CARBIDES IN THE TUNGSTEN–MANGANESE–CARBON SYSTEM. Telegus, V. S. Visn. L'viv. Derzh. Univ., Ser. Khim., No. 9, 29-33(1967). (In Ukrainian).

X-ray analysis of hot-pressed W–Mn–C alloys confirmed the existence of the ternary carbides W_3Mn_3C and WMn_xC_y. The former has a cubic η_1 carbide lattice and the latter a hexagonal cell of the $W_6Co_6C_4$ type. The carbide $(W,Mn)_2C$ of variable composition was also found. This has a hexagonal lattice with a = 2.795, c = 4.490 Å and c/a = 1.606 for the composition W 20, Mn 45, and C 35 at.%. (P.G.C.)

49843 CRYSTAL STRUCTURES OF ThC_2. Bowman, Allen L.; Krikorian, N. H.; Arnold, George P.; Wallace, Terry C.; Nereson, Norris G. (Los Alamos Scientific Lab., N. Mex.). Contract W-7405-eng-36. Acta Crystallogr., Sect. B, 24: 1121-3(1968). (LA-DC-9055).

A high-temperature neutron diffraction study of ThC_2 shows a cubic phase above 1480°C and a tetragonal phase between 1430 and 1480°C. The cubic phase has the KCN-type structure, $a_0 = 5.80_8$ Å at 1550°C, with randomly oriented C_2 groups. The structure of the tetragonal phase is derived from the cubic structure by compression along the c axis, with the C_2 groups randomly oriented in the plane perpendicular to the c axis. The body-centered cell parameters are $a_0 = 4.221$, $c_0 = 5.394$ Å at 1450°C. The structure parameters of the C_2 type monoclinic phase were redetermined, giving a C–C distance of 1.32 Å, in close agreement with the values for other transition metal dicarbides. (auth) (Denmark)

49844 THERMOELASTOPLASTIC STABILITY OF LAMINATED FUEL ELEMENTS. Guerrini, B. (Univ., Pisa, Italy). pp 343-65 of Fabrication of Ceramic Type Power Reactor Fuel Elements. VIII Nuclear Congress, Rome, 19–20 June 1963. Roma, Comitato Nazionale Energia Nucleare, 1967. (In Italian).

See CONF-193-(Vol.1).

A theoretical approximation study was made of the thermoelastic equilibrium stability of laminated fuel elements. This theoretical study is outlined and examines the problem of the determination of the stability limits of the equilibrium of an elastic lamina exposed to a given thermal stress. An experimental installation was designed and constructed to determine the effective behavior of laminated fuel elements exposed to given temperature distributions. This installation is described in detail and the results obtained in a first series of tests, on five stainless steel laminates, are reported. The behavior of the laminates is characterized by two distinct phases. In the first phase the initial deformation is significantly different from lamina to lamina. In the second phase a phenomenon of thermoelastic shrinkage is clearly evident which is essentially independent of the initial deformation of the lamina. Between the two phases there is a variable ratio from lamina to lamina. (J.S.R.)

49845 LINE STRENGTHS IN X-RAY PATTERNS OF GRAPHITE STRUCTURES. Kurdyumov, A. V.; Pilyankevich, A. N. (Inst. of Materials Science Problems, Kiev). Sov. Phys.-Cryst. (Engl. Transl.), 13: 245-8(Sept.-Oct. 1968).

Translated from Kristallografiya, 13: 311-15(Mar.-Apr. 1968).

Intensities are calculated for all possible lines given by a powder of three-dimensionally ordered graphite with CuKα radiation, with allowance for the temperature factor. The intensity changes on going to a three-dimensionally disordered structure are discussed. Observed scattering curves for x rays are given for graphite materials differing in crystalline perfection. (auth)

49846 STUDY OF THE REFRACTORY PROPERTIES AND STRUCTURE OF THE PHASES AT HIGH TEMPERATURE IN THE SYSTEM ZIRCONIA–LANTHANUM OXIDE. Rouanet, Alain (Centre National de la Recherche Scientifique, Montlouis, France). Compt. Rend., Ser. C, 267: 395-7(July 29, 1968). (In France).

The system zirconia–lanthanum oxide was studied at very high temperature up to the melting point of the products. The proposed diagram shows the nature of the region of homogeneity of the phases up to 1800°C as well as the refractory properties of the products of different compositions. (tr-auth)

49847 OXYGEN ION CONDUCTION IN THE ZrO_2–Gd_2O_3 SYSTEM. Peters, H.; Radeke, K. H. Monatsber. Deut. Akad. Wiss. Berlin, 10: 53-9(1968). (In German).

Conductivity measurements were made in the $ZrO_2-Gd_2O_3$ system in the composition range from 28 to 36 mol % Gd_2O_3, where superstructure lines of the pyrochlor phase are detected, and around the compound $Zr_3Gd_2O_7$. The results showed that the conductivity is very strongly dependent on the concentration of Gd_2O_3. The activation energy first increases with increasing defects and then decreases in the region of the pyrochlor phase to very low values. The pattern of the activation energy with variation of the gadolinium content can be explained by means of a simple geometric consideration of the motion of the oxygen ions through the lattice. (J.S.R.)

49848 SOME PROPERTIES AND STRUCTURE OF COMPOUNDS OF VARIABLE COMPOSITION IN THE SYSTEM TiC–ZrO_2. Gropyanov, V. M. Ogneupory, No. 6, 55-6(June 1968). (In Russian).

The results of the investigation of compounds of variable composition in the system $TiC-ZrO_2$ at different temperatures are reported. The dependence of the lattice parameters of the oxycarbide phase occurring in the system on the content of bound carbon and the temperature was established. The effect of chemical processes, proceeding at high temperatures, on the sintering of the cermets was determined. (tr-auth)

49849 DIFFUSION OF CARBON AND URANIUM IN URANIUM CARBIDE. Lee, Hee Myong; Barrett, L. R. (Imperial Coll. of Science and Tech., London). J. Nucl. Mater., 27: 275-84(Sept. 1968).

The diffusion of carbon and uranium in uranium carbide has been measured using radioactive tracers and sectioning techniques. The diffusion equations in stoichiometric uranium carbide as a function of temperature are: for the carbon, $D = 1.75 \exp(-63{,}000/RT)$ at 1266 to 1684°C; for the uranium, $D = 8.47 \exp(-104{,}000/RT)$ at 1505 to 1863°C. The excess carbon in the stoichiometric composition results in an increase in the diffusion coefficients and a decrease in the activation energy. The mechanism for diffusion is considered to be an interstitial for carbon and a vacancy for uranium. Data for carbon-rich and carbon-deficient compositions are included and the possibility of grain boundary diffusion is also considered. There is clear evidence for grain-boundary diffusion in hypostoichiometric arc-melted UC at low temperatures. (auth)

49850 PHASE DIAGRAMS OF THE SYSTEMS VC–ZrC AND VC–HfC. Ettmayer, P.; Kieffer, R.; Usner, L. (Technische Hochschule, Vienna). Planseeber. Pulvermet., 16: 108-13 (July 1968). (In German).

The mutual solubilities of the monocarbides VC–ZrC and VC–HfC, respectively, were determined by x-ray methods in the corresponding pressed and sintered powder mixtures. In the system VC–ZrC at 2270°C they were: 1.7 mole % VC and 0.3 mole % ZrC; at the eutectic temperature of 2550°C: 8.1 mole % VC and 7.0 mole % ZrC and in the system VC–HfC at 2270°C: 3.4 mole % VC and 4.5 mole % HfC; at the eutectic temperature of 2650°C: 8.8 mole % VC and 14.3 mole % HfC. The constitution of the two pseudobinary systems was determined by means of a simple Seger cone method. It was found that these are simple eutectic systems and the supposition that the miscibility gap in the solid state is closed at high temperatures is thus not confirmed for the two carbide pairs. (auth)

49851 CARBIDE PRECIPITATION ON IMPERFECTIONS IN SUPERALLOY MATRICES. Kotval, P. S. (Union Carbide Corp., Kokomo, Ind.). Trans. Met. Soc. AIME, 242: 1651-6 (Aug. 1968).

Dislocation substructures in superalloy matrices of varying compositions have been studied. In general, it has been found that the alloys can be classified into high, medium, and low stacking fault energy classes based on the type of dislocation substructure observed in the matrix and that the substructure can be correlated to the stacking fault energy. The effect of different types of dislocation substructure and dislocation reactions on the intragranular precipitation of carbide phases has been studied. In a Ni–Cr–Mo–Fe matrix, precipitation of MC carbides in association with stacking faults has been observed. (auth)

49852 PHASE RELATIONS IN THE Th–U–N TERNARY SYSTEM AT 1000°C. Venard, J. T.; Spruiell, J. E. (Oak Ridge National Lab., Tenn.). J. Nucl. Mater., 27: 257-63(Sept. 1968). (ORNL-P-3711).

Potential advantages of thermal-breeder fuels having a metallic thorium matrix with a dispersion of (Th,U)N led to an investigation of the Th–U–N ternary system. The investigation was limited to the 1000°C isotherm at 50 at % N and below using alloys prepared by powder metallurgical techniques. In the Th–U–N system the 1000°C equilibration time was found to be 80 to 100 hr. The predominant feature of this isotherm is a three-phase equilibrium among uranium metal, thorium metal, and the compound $(Th_xU_{1-x})N_y$. The most uranium-rich compound in equilibrium with metallic thorium was found to be $(Th_{0.944}U_{0.056})N_{0.866}$. The 1000°C standard free energy of formation of ThN was estimated to be about −51,100 cal/g mole. (auth)

49853 PHASE STUDIES OF THE Zr–H SYSTEM AT HIGH HYDROGEN CONCENTRATIONS. Moore, K. E.; Young, W. A. (Atomics International, Canoga Park, Calif.). J. Nucl. Mater., 27: 316-24(Sept. 1968).

The phase boundaries of the Zr–H system have been defined at high hydrogen concentrations, on the basis of studies performed on zirconium hydrides containing 4 at. % uranium. The methods used include high-temperature x-ray diffraction, electrical resistance, dilatometry, and, to a limited extent, hot stage microscopy. The $(\delta + \epsilon)$ two-phase region was found to exist between $ZrH_{1.64}$ and $ZrH_{1.74}$ at 24°C. This region diminishes in width with increasing temperature and closes at 455°C and $ZrH_{1.70}$. From this point, a single boundary, sloping toward higher hydrogen concentrations, separates the δ and ϵ single-phase regions. Precise lattice parameter measurements indicate that first-order transitions occur at the boundaries of the two-phase region. Theoretical considerations suggest that the $\delta \rightleftharpoons \epsilon$ transition is second order. (auth)

49854 MoO_3 WHISKERS WITH DISTURBED STRUCTURE. Saalfeld, H.; Jarchow, O. (Univ., Hamburg). Z. Kristallogr., 126: 241-3(July 1968). (In German).

Molybdenum trioxide whiskers grown in a gas atmosphere show x-ray diagrams with diffuse reflections $h + k = 2n + 1$. This phenomenon can be explained by twin lamellae where the contact zones consist of disordered layers with statistical distribution in the crystal. (auth)

49855 ON THE AGEING AND PRECIPITATION IN Fe–Be ALLOYS. Nakagawa, Yukiya G.; Hirano, Ken-ichi; Koda, Shigeyasu (Tohoku Univ., Sendai). Nippon Kinzoku Gakkaishi, 32: 510-15(1968). (In Japanese).

Decomposition in the supersaturated solid solution of Fe-11.3 atomic percent Be alloy has been investigated by optical and transmission electron microscopic observations, thermal analysis, hardness tests, and electrical resistance measurement. The results of the x-ray structural measurements are compared with those of previous workers. A clear difference has been confirmed between the sequence of structures for aging temperatures below 400°C and above 500°C. The age hardening below 400°C can mainly be attributed to the massive short range order, the pseudo-FeBe $L2_0$ order, the Fe_3Be DO_3 order and the side-band structure (sinusoidal modulation of composition), which were detected by the previous x-ray measurements and confirmed by the present specific heat and electrical resistance measurements. The age hardening above 500°C can be attributed to the continuous and the discontinuous precipitation. Kinetic analysis of the heat evolution in the specific heat versus temperature curves has shown the activation energy for the formation of DO_3 order from $L2_0$ order to be about 25 kcal/mol which appears to be as reasonable as for the migration of Be atoms in the bcc lattice of Fe. (auth)

49856 TO KNOWLEDGE OF GROWING OF STRUCTURE COMPONENTS AND OF CHANGING OF TENSILE PROPERTIES IN WC–Co ALLOYS WITH VARIOUS Co-CONTENTS. Grewe, H.; Walter, P. (Hartmetallwerk der Firma Ledermann and Co., Horb, Ger.). Metall, 22: 707-16(July 1968). (In German).

The growth of the structural components and the dependent alteration of the stability properties were investigated in WC–Co alloys with various Co contents using annealing methods. Metallographic, physical, and mechanical-engineering testing methods were also used. It was shown that the growth of the Co intermediate layer limits that of the tungsten carbide crystallite and the alteration of the physical and stability properties directly and indirectly. The reaction-controlling process for the growth of the Co intermediate layer is a thermally activated solution process of tungsten carbide as W and C in the binding phase. A dependence of the size of the activation energy on the Co content could not be established within the framework of these studies, which correspond essentially to the results from sintering studies. (tr-auth)

Radiation Effects

Refer also to abstracts 49773, 49783, 49789, and 50732.

49857 (GEAP-5626) POST-IRRADIATION EXAMINATION OF ZIRCALOY-2- AND INCOLOY-800-CLAD FUEL RODS IRRADIATED TO 7000 MWd/TU IN THE CONSUMERS BIG ROCK POINT REACTOR. Hazel, V. E. (General Electric Co., San Jose, Calif. Nuclear Fuels Dept.). Apr. 1968. Contract AT(04-3)-361. 18p. Dep. CFSTI.

Irradiated fuel rods, from the Big Rock Point Reactor, were given a nondestructive examination consisting of visual inspection, gamma scanning, dimensional profiling, and leak testing. Two Zircaloy-2 clad rods were examined by neutron radiography and metallographic methods to determine failure mechanisms. Visual examination of a failed fuel rod clad with Incoloy-800 revealed straight line cracks, probably initiated at the tube weld seam, of an intergranular nature, which may indicate that this cladding material is inferior to Zircaloy-2. The various types of failures are illustrated photographically. (P,G.C.)

49858 (WAPD-TM-631) PERFORMANCE OF FUEL RODS HAVING 97 PERCENT THEORETICAL DENSITY UO_2 PELLETS SHEATHED IN ZIRCALOY-4 AND IRRADIATED AT LOW THERMAL RATINGS (LSBR/LWBR DEVELOPMENT PROGRAM). Engel, J. T.; Meieran, H. B. (Bettis Atomic Power Lab., Pittsburgh, Pa.). July 1968. Contract AT(11-1)-Gen-14. 151p. Dep. CFSTI.

Two fuel rods in which solid, 97% theoretical density UO_2 pellets were sheathed in Zircaloy-4 were irradiated in the MTR reactor pressurized water B-4 loop to study the irradiation swelling characteristics of UO_2 fuel rods. These rods were designed with a minimum void volume so that fuel swelling could manifest itself as measurable external dimensional changes, allowing a comparison with the irradiation swelling characteristics previously observed in UO_2 fuel plates irradiated to burnups in excess of 30×10^{20} fissions/cc. The observed fuel swelling rate for both rods did not contradict those found in the reference UO_2 plates (0.7% $\Delta V/10^{20}$ fissions/cc). It should be noted that fuel swelling is now considered to be highly temperature-dependent, and volume increases will be greater than 0.7% $\Delta V/10^{20}$ fissions/cc at temperatures greater than ≈2500°F. The stress and strain patterns in the two rods were calculated by an analysis incorporated in the computer program CYGRO-2. The calculated strains were greater than the measured strains; however, failure of the cladding from excessive strain caused by the fuel growth was calculated within the range of uncertainty of the strain failure criteria. (auth)

49859 EXPERIENCE WITH CERAMIC FUEL ELEMENTS FOR ORGANIC REACTORS. Arneson, S. O.; Balif, J. L. (Atomics International, Canoga Park, Calif.). pp 325-32 of Fabrication of Ceramic Type Power Reactor Fuel Elements. VIII Nuclear Congress, Rome, 19–20 June 1963. Roma, Comitato Nazionale Energia Nucleare, 1967.

See CONF-193-(Vol.1).

Results of irradiation tests on Al-clad Ni-bonded U–Mo alloy fuel elements, multirod clusters of SAP-clad UO_2, and UO_2-stainless steel dispersion elements are reported. Design and fabrication of the fuel elements are discussed as are causes of failures, reaction products, and reaction kinetics. (P,G.C.)

49860 PROBLEMS OF FISSION PRODUCT DIFFUSION IN GRAPHITE FUEL ELEMENTS. Cesoni, G.; Chinaglia, B.; Walther, H. (Societa Ricerche Impianti Nucleari, Saluggia, Italy). pp 435-52 of Fabrication of Ceramic Type Power Reactor Fuel Elements. VIII Nuclear Congress, Rome, 19–20 June 1963. Roma, Comitato Nazionale Energia Nucleare, 1967.

See CONF-193-(Vol.1).

A method, using gamma radiation of ^{140}La, was developed to measure the distribution of fission products in thin specimens of

pyrolytic graphite. A fast migration rate was observed for ^{140}Ba which indicates that pyrolytic graphite is not an effective diffusion barrier for Ba. Activation analysis techniques were used to determine traces of U in single-coated particles. Equations, which may be adapted to computer programming, were developed to apply numerical solutions to diffusion problems. (P.G.C.)

49861 EXPERIMENTS ON FISSION GAS RELEASE FROM URANIUM DIOXIDE BY MEANS OF THE POST-IRRADIATION ANNEALING TECHNIQUE. Cesoni, G.; Frigerio, G.; Gerevini, T. (Fiat, Turin). Contract 021-60-9RDI. pp 259-72 of Fabrication of Ceramic Type Power Reactor Fuel Elements. VIII Nuclear Congress, Rome, 19–20 June 1963. Roma, Comitato Nazionale Energia Nucleare, 1967.
See CONF-193-(Vol.1).

Equipment and procedures used for measuring the fission gas retention ability of UO_2 fuel pellets by post-irradiation annealing techniques are described. Possible mechanisms involved in release of fission gases during heating and cooling bursts are discussed. (P.G.C.)

49862 FISSION INDUCED SORPTION OF KRYPTON IN URANIUM CARBIDE. Gautsch, O. (CCR-Euratom, Ispra, Italy). J. Nucl. Mater., 27: 310-15(Sept. 1968).

Experimental data on the fission induced sorption of krypton in uranium carbide surfaces indicated that as a first step of the sorption mechanism, adsorption of the inert gas occurs. In a second step, the adsorbed atoms start to migrate into the bulk of the uranium carbide. Experimental data on the thermal release and on the knock-out of the sorbed krypton showed that sorption approached a saturation value within 4 days of irradiation at the given experimental conditions. (auth)

49863 ANALYSIS OF FISSION GAS ESCAPE FROM REACTOR FUEL DURING ISOTHERMAL IRRADIATION. Iwamoto, Kazumi (Japan Atomic Energy Research Inst., Ibaraki); Oishi, Jun. J. Nucl. Sci. Technol. (Tokyo), 5: 387-96(Aug. 1968).

The fission gas escape during fissioning in fuel was interpreted with a newly proposed escape mechanism which comprises successive processes of release from trapping sites, diffusion of the released fission gas nuclides, and desorption from the fuel surface. The expression for the release rate of fission gas was derived from a simple mathematical model postulating a continuous activation energy spectrum for the release reaction of trapped nuclides. The proposed mechanism satisfactorily explains observed data reported in literature on the dependence of the escape rate on decay constant, the contribution of the precursor, and the change of escape rate with irradiation time. There appears to be only a small effect brought by diffusion of the released nuclides on the escape rate, which can thus be considered to be controlled mainly by the release reaction from the trapping sites. The present model based on the release from trapping sites can also qualitatively explain the influence of differences in irradiation conditions such as time and neutron flux. (auth)

49864 PHOTOMOBILITY OF DISLOCATIONS IN IRRADIATED POTASSIUM CHLORIDE CRYSTALS. Ermakov, G. A.; Nadgornyi, E. M. Dokl. Akad. Nauk SSSR, 181: 76-8(July-Aug. 1968). (In Russian).

Potassium chloride crystals having a dislocation density of about $10^4/cm^2$ were given a ^{60}Co gamma ray dose of 10^8 rads in order to create color centers. After irradiation the crystals were stored in the dark or subjected to partial decolorization (under natural illumination). The dislocation movement rates before and after artificial illumination at different applied shear stresses were determined by selective etching with $PbCl_2$ in alcoholic solution. The dark dislocation velocity of irradiated colored crystals fell as compared with the initial unirradiated KCl crystal. Absorption spectra showed that this behavior could be correlated with the appearance of F- and M-color centers in the irradiated crystals. Irradiation of the colored crystals with artificial light slowed down the dislocation velocity as compared to the dislocation velocity before light illumination. In decolorized crystals, light had no effect on the dislocation velocity. It is believed that the phenomenon is due to the creation of stable pinned centers which have a high reaction energy with the dislocations. (TTT)

Plastics and Other Materials

Refer also to abstract 49773.

49865 (BNWL-866) CHARACTERIZATION OF RECENTLY DEVELOPED HIGH-TEMPERATURE POLYMERS: RADIATION RESISTANCE OF POLYIMIDE AT ELEVATED TEMPERATURES. Gordon, N. R.; Langley, N. R. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). July 1968. Contract AT(45-1)-1830. 8p. Dep. CFSTI.

The effect of γ radiation on the mechanical properties of a glass-reinforced polyimide plastic at elevated temperatures was analyzed. No systematic effect was found from γ radiation doses up to 10^9 R on the modulus of elasticity or strength at constant test temperature. Heat treating the polyimide before irradiation produced improved mechanical properties. Exclusion of air to eliminate oxidative degradation during irradiation contributed no improvement. The mechanical performance of the plastic at elevated temperatures is maintained in radiation environment to doses of at least 10^9 R permitting the use of the polyimide in nuclear reactor application. (F.S.)

PHYSICS (GENERAL)

Astrophysics and Cosmology

Refer also to abstracts 49151, 50060, 50063, 50270, 50355, and 50464.

49866 ELECTROMAGNETIC FIELDS IN SPACE. Scientia (Milan), 103: 99-111(1968). (In German).

The largest part of cosmic material is in the plasma state. The magnetic and electric fields in the cosmos determine the properties of such cosmic plasmas. Magnetic fields in interplanetary space can be measured by the Zeeman effect, polarization of stellar light, and through synchrotron radiation of high energy particles. The fields have a strength of 10^{-5} to 10^{-6} G. Magnetic fields on the stars and the sun are studied by the Zeeman effect, and on stars reach several thousand Gauss. In the polar regions the solar magnetic field is about 1 G; in sunspots it reaches several thousand Gauss. Jupiter also has a strong magnetic field; Mars, Venus, and the moon have only weak fields, detected by direct study with space probes. The interplanetary magnetic field has been shown by space probes and satellites to have a spiral structure and a strength of 10^{-5} G. Electric fields in the ionosphere and magnetosphere of the earth have been measured with Ba clouds. At mean geomagnetic latitudes they have a strength of several V/cm; at higher latitudes, in the northern lights zone, the strength is an order of magnitude higher. (BBB)

49867 INVESTIGATIONS OF A MILKY WAY FIELD IN CIRCINUS (SA 195). I. CATALOG OF PHOTOGRAPHIC UBV PHOTOMETRY OF 634 STARS. Saerg, Katrin; Roslund, Curt; Engver, Nils (Univ. of Lund, Sweden). Ark. Astron., 4: 405-18(1968).

A catalog of V magnitudes and G−V and U−B colours determined by photographic technique is presented for 634 stars in a region of 0.17 square degrees in SA 195 in Circinus. The limiting magnitude of the catalog is V = 15.25. (auth)(Sweden)

49868 PHOTOMETRIC STANDARD SEQUENCES IN VELA WITH AN OUTLINE OF A SEARCH FOR ASSOCIATIONS OF INTERMEDIATE-TYPE STARS. Loden, L. O. (Stockholm Observatory, Saltsjoebaden, Sweden). Ark. Astron., 4: 425-33 (1968).

Photoelectric UBV photometry of 130 stars in the Puppis–Vela border region was performed at the Boyden Observatory, primarily in order to give standard connection sequences for continued photoelectric or photographic photometry in the actual field. A study of the absorption conditions shows no noticeable color excess within 1 kpc. Particular attention was paid to one region (11) in which a large number of star couples with apparently coinciding magnitude and spectral class might indicate the presence of intermediate-type associations. (Sweden)

49869 PHOTOELECTRIC SEQUENCES IN PUPPIS. Lindoff, Ulf (Univ. of Lund, Sweden). Ark. Astron., 4: 433-40(1968).

Magnitudes and colors were measured photoelectrically in the UBV system for 78 stars in three different regions in Puppis. (Sweden)

49870 INVESTIGATIONS OF A MILKY WAY FIELD IN SCORPIUS. V. STRENGTHS OF INTERSTELLAR K LINE AND λ 4430 ABSORPTION BAND. Roslund, Curt; Ardeberg, Arne (Univ. of Lund, Sweden). Ark. Astron., 4: 441-55(1968).

Equivalent widths of the K line of singly ionized calcium and central depths of the unidentified broad absorption feature centered at 4430 Å were measured in the spectra of 55 O and B stars in a Milky Way field in Scorpius. The investigation shows that the agent responsible for the λ 4430 absorption is concentrated in clouds of obscuring matter and that the distribution of ionized calcium on a large scale follows that of the interstellar dust in this part of the galaxy. It also confirms earlier observations that the ratio of λ 4430 absorption to selective extinction of starlight is low in the direction of the galactic centre. (Sweden)

49871 THE OPEN CLUSTERS NGC 5617, Ly 2, AND Tr 12. Lindoff, Ulf (Univ. of Lund, Sweden). Ark. Astron., 4: 471-91(1968).

Photographic magnitudes were determined in the UBV-system for the southern open clusters NGC 5617, Ly 2, and Tr 12. The color excesses are $O^m.53$ (irregular) for NGC 5617 and $O^m.19$ for Ly 2. The distances are 1150 pc and 1100 pc, respectively. Tr 12 is probably no real cluster. (Sweden)

49872 A SUGGESTED METHOD TO REDUCE THE SCATTERED LIGHT IN SUNSPOT PHOTOMETRY. Kusoffsky, Ulf (Stockholm Observatory, Saltsjoebaden, Sweden). Ark. Astron., 4: 457-64(1968).

The intensity ratio between sunspot umbra and the adjacent photosphere was observed with a pinhole device, which eliminates to a great extent the diffracted light from the objective lens. Observations show that the method is quite useful. If corrections are made as well for nondiffracted stray light measured outside the limb, reliable results seem to be obtained. (Sweden)

49873 A STUDY OF COLOR EXCESS IN KAPTEYNS SELECTED AREA 4. Ekdahl, Yngve. Ark. Astron., 4: 507-25 (1968).

For Selected Area 4 (l = 140°, b = +32°) a catalogue gives corrected photovisual (yellow) magnitudes and new photographic (blue) magnitudes. For this area the colour-excess distribution was studied on the basis of the catalogue data. It was found that the excess varies over the area. The distance of the absorbing layer was determined. (Sweden)

49874 THE OPEN CLUSTERS Tr 22 AND Ho 17. Lindoff, Ulf (Univ. of Lund, Sweden). Ark. Astron., 4: 493-503(1968).

Photographic magnitudes in the UBV system and based on a photoelectric sequence were determined for stars in the open clusters Tr 22 and Ho 17. Spectral classes were determined for the brighter stars. The color excess is $O^m.53$ for Tr 22 and $O^m.54$ for Ho 17. The distances are 1700 pc and 1660 pc, respectively. Ho 17, although containing very few stars, seems to be a real cluster. (Sweden)

49875 PHOTOELECTRIC OBSERVATIONS OF ζ AURIGAE DURING THE ECLIPSE 1963–1964. Sinnerstad, Ulf (Onsala Space Research Observatory, Sweden). Ark. Astron., 4: 527-31 (1968).

49876 THE STRUCTURE OF GALACTIC NEUTRAL HYDROGEN IN A REGION OF CYGNUS. Winnberg, Anders (Onsala Space Research Observatory, Sweden). Ark. Astron., 4: 533-69(1968).

Observations of the 21-cm hydrogen line were carried out in a region of Cygnus centered on the new galactic coordinates. The observations were made with a 12-meter parabolic antenna and a frequency-switched radiometer. The main intention of the investigation was to trace the outer hydrogen arm of the Galaxy which displays an intensity minimum in this direction. All the hydrogen line profiles were resolved into a number of Gaussian components by means of a special computer program. The results of this analysis are given. It is assumed that the density of the outer arm has the spatial distribution of a circular Gaussian cylinder. By applying two kinematical models and one dynamical model to the arm a number of different values for its physical properties were derived. In Model 1 it is assumed that the elements of the arm are moving in concentric circles according to Schmidt's latest rotation law. In Model 2 there is a contraction velocity of 30 km/s superposed on the ordinary circular velocity. This model is based on the fact that the outer arm in the anticenter is approaching the Sun with a velocity of 29.5 km/s. In Model 3, which is proposed by Lindblad, the motion of the arm is assumed to be governed by the perturbation from a bisymmetric density wave in the inner parts of the Galaxy. This model is fitted in two different ways to the observed radial velocities. The distances to the outer arm according to the different models are listed and the average values of the various physical data of the arm are given. In the discussion of the models it was found that Model 2 places the outer arm partly inside the Perseus arm. Since the velocities of the two arms are different (the Perseus arm is assumed to have pure circular motion), Model 2 must be rejected because of gasdynamical considerations. However, neither Model 1 nor Model 3a,b give too short distances between the Perseus arm and the outer arm. It is pointed out that the course of the outer arm according to Westerhout's interpretation of the Kootwijk survey is different from the one found in this work. The outer arm is here seen clearly separated from the Perseus arm over the entire longitude interval. For the Perseus arm and the intermediate arm the variation of the mean surface density with galactic latitude was derived. As the coverage in latitude is insufficient, however, no detailed discussion of these arms is made. (Sweden)

49877 MEASUREMENTS OF POLARIZATION AND ELECTRON DENSITY IN THE FLARE SPRAY ON JULY 11, 1966. Stiber, Goete (Swedish Astrophysical Station, Anacapri, Italy). Ark. Astron., 4: 571-86(1968).

In a search for sources of continuous emission, the polarization of the great spray-type flare of July 11, 1966, was measured. Po-

larization lower than predicted by the theory of electron scattering was determined. The plane of polarization was in good agreement with the expected if Thomson scattering were responsible for the continuous spectrum. Using the discrepancy of the measured and theoretical degree of polarization, the magnitude of the electron density was derived since the difference probably arises from the fact that the contribution to the spectrum from the free–free and free–bound transitions of hydrogen increases with increasing electron density. With the additional assumption that the flare had axial symmetry and a thickness in the line of sight of 20,000 km, electron densities ranging from 1.4×10^{11} to 2.5×10^{11} electrons per cm^3 in the central parts of the flare were obtained. Finally, an estimation of the electron density in the prominences visible during the solar eclipse of June 30, 1954, was made. (Sweden)

49878 THE OPEN CLUSTER NGC 2533, NGC 2567, NGC 2571, AND Ru 58. Lindoff, Ulf (Univ. of Lund, Sweden). Ark. Astron., 4: 587-611(1968).

Photographic magnitudes in the UBV system, based on a photoelectric sequence, were determined for stars in the open clusters NGC 2533, NGC 2567, NGC 2571, and Ru 58. Spectral classes were obtained from objective prism plates for some of the brighter stars. The colour excess is O^m .34 for NGC 2533, O^m .72 for NGC 2567, and O^m .32 for NGC 2571. The distances are 2800 pc, 1700 pc, and 2050 pc, respectively. Ru 58 is probably no real cluster. In NGC 2533 a very red star ($(B-V)_0 \sim 3.5$) might be a physical member. (Sweden)

49879 DETERMINATION OF THE LUMINOSITY FUNCTION AND THE STELLAR DENSITY IN THE VICINITY OF THE SUN. Arakelyan, M. A. (Byurakan Astrophysical Observatory, USSR). Dokl. Akad. Nauk SSSR, 179: 555-7(1968). (In Russian).

It is pointed out that derivation of the function characterizing the stellar density and luminosity in the vicinity of the sun is based on spherical shells with the common center in the sun. The visual stellar density is determined by counting stars in each selected shell at the distance r from the sun. The luminosity is determined from the brightness of stars in the corresponding shell. The stellar density D(r) and the luminosity S(M) are approximately expressed by linear functions. This method can yield incorrect results because the visual star brightness m at a certain distance from the sun can become unobservable and the counting results do not include all the stars. Therefore, the visual brightness is connected with the absolute brightness by the formula: $m = M + 5 \lg r - 5$. The change of density depending on the brightness can be expressed by the formula $dD(r) = D_0 S(M)$, where D_0 is the real stellar density. The variation $dD(r)/dr$ can be constant only when the luminosity function diminishes exponentially. A new method is proposed for determining the luminosity function and computing the stellar density. This method is based on the use of Poisson's distribution $D_0(M)$ the density as function of the absolute brightness of the star. This density is compared with a mean density distribution in a sphere with radius r. The total stellar density is given by $D_0 = \int_{-\infty}^{\infty} D_0(M)dM$ and the luminosity function $S(M) = D_0(M)/D_0$. This method makes it possible to use stars at different distances and to determine partial densities in the sphere. (ATD)

49880 HIGH-RESOLUTION INTERFEROMETRY OF SMALL RADIO SOURCES USING INTERCONTINENTAL BASE LINES. Kellermann, K. I. (National Radio Astronomy Observatory, Green Bank, W. Va.); Clark, B. G.; Bare, C. C.; Rydbeck, O.; Elldér, J.; Hansson, B.; Kollberg, E.; Hoglund, B.; Cohen, M. H.; Jauncey, D. L. Astrophys. J., 153: L209-14(Sept. 1968).

Radio telescopes located near Green Bank, West Virginia, and Onsala, Sweden, were used as elements of an interferometer with a base line of 6319 km. Observations at 18 cm (35×10^6 λ base line) and at 6 cm (105×10^6 λ base line) show that a number of radio galaxies and quasi-stellar sources contain components with angular dimensions of the order of 0.001″ or less. In two Seyfert galaxies, the upper limits to the sizes of regions of time-varying emission indicate that the sources do not expand with extreme relativistic velocities in the manner suggested by Rees and Simon. (auth)

49881 EQUIVALENT WIDTH OF H-ALPHA IN LATE-TYPE STARS. Weistrop, Donna (Carnegie Institution of Washington, D. C. California Inst. of Tech., Pasadena). Publ. Astron. Soc. Pac., 79: 546-50(Dec. 1967).

The use of the equivalent width of Hα as a luminosity criterion for late-type stars is investigated. The method is found to be no more accurate than MK luminosity classifications. Two spectrograms are presented which indicate a change in the Hα equivalent width in 22 Vul over a three-year period. (auth)

49882 DETERMINATION OF STELLAR MAGNITUDES BY ELECTRONOGRAPHY. Walker, Merle F. (Univ. of California, Santa Cruz); Kron, Gerald E. Publ. Astron. Soc. Pac., 79: 551-68(Dec. 1967).

The application of electronography to stellar photometry is investigated, and it is shown that a linear relationship between the area under the density profile of the star image and the intensity of the star exists over a range of at least 4.6, and probably in excess of 5, magnitudes beginning at the plate limit. The advantages of this method of photometry are discussed. (auth)

49883 MODEL CALCULATION OF H II REGION TEMPERATURES. Goss, W. Miller; Dieter, Nannielou H. (Univ. of California, Berkeley). Publ. Astron. Soc. Pac., 79: 575-83(Dec. 1967).

It is shown quantitatively that the presence of a temperature variation within an H II region affects the determination of the electron temperature by the radio-frequency recombination-line method. The effect is always one of deducing too low a temperature from the observations. (auth)

49884 PRE-OUTBURST SPECTRUM OF NOVA DELPHINI 1967. Stephenson, C. B. (Case Western Reserve Univ., Cleveland). Publ. Astron. Soc. Pac., 79: 584-8(Dec. 1967).

Two objective-prism plates of the field of Nova Delphini 1967 furnish rather well-exposed pre-outburst spectra of this nova seven years before the 1967 outburst. On these 600 Å/mm plates the spectrum was continuous, very blue and strong in the ultraviolet, like an unreddened O or very early B star. (auth)

49885 PERIODIC CHANGES IN THE SPECTRUM VARIABLE HR 234. Guderley, Edith (Ohio State Univ., Columbus, Ohio Wesleyan Univ., Delaware). Publ. Astron. Soc. Pac., 79: 589-92 (Dec. 1967).

The spectrum variations of HR 234 were observed; their period, based on the Ca II K line, was found to be 2^d156. Lines of Fe I, Fe II, Cr I, Cr II, Mg II, Ti II, Sr II, and Eu II were also found, although no trace of Si II appeared. (auth)

49886 VARIABLE NUCLEUS OF NGC 4254. Walker, Merle F. (Univ. of California, Santa Cruz). Publ. Astron. Soc. Pac., 79: 593-9(Dec. 1967).

Re-examination of plates of NGC 4254 taken by Lampland confirms the existence on them of changes in the nucleus. Photographs taken with large reflectors in good seeing suggest that these variations, if real, were due to changes in the brightness of a stellar feature near the nucleus. The recent observations yield no conclusive evidence of variability of this object, but additional observations are highly desirable. (auth)

49887 POLARIMETRIC OBSERVATIONS OF SPIRAL GALAXIES. Appenzeller, Immo (Univ. of Chicago). Publ. Astron. Soc. Pac., 79: 600-6(Dec. 1967).

The extragalactic systems NGC 3031, NGC 4594, NGC 5194, and NGC 5457 were observed polarimetrically. Linear polarization between 0.1 and 1.0% was detected in the spiral arms of all four galaxies. The planes of vibration indicate that reflection as well as interstellar absorption of starlight by the internal dust clouds of the observed galaxies contribute to the polarized light. (auth)

49888 OBJECTIVE-PRISM SPECTRUM OF W VELORUM. Hoffleit, Dorrit (Case Western Reserve Univ., Cleveland). Publ. Astron. Soc. Pac., 79: 607-10(Dec. 1967).

A description is given of an unusually fine objective-prism spectrum of the long-period variable W Velorum, found on a Bosscha plate taken 113 days (or 0^d3) after maximum light, spectral class M8e. Other objective-prism plates, taken near minimum, show far less detail. (auth)

49889 VISUAL AND PHOTOGRAPHIC OBSERVATIONS OF A WHITE-LIGHT FLARE ON MAY 23, 1967. De Mastus, H. L.; Stover, R. R. (Sacramento Peak Observatory, Sunspot, N. Mex.). Publ. Astron. Soc. Pac., 79: 615-21(Dec. 1967).

A white-light solar flare was visually and photographically observed on May 23, 1967. Maximum white-light phase preceded the Hα intensity maximum, but the event is otherwise similar to earlier reported white-light flares. (auth)

49890 ON THE STRUCTURE AND EVOLUTION OF W URSAE MAJORIS STARS. Kraft, Robert P. (Carnegie Institution of Washington, D. C. California Inst. of Tech., Pasadena). Publ. Astron. Soc. Pac., 79: 395-413(Oct. 1967).

Current ideas on the formation, structure, and evolution of the main-sequence contact binaries of type W UMa are reviewed. It is shown from relative star counts that W UMa stars cannot now be transferring mass from one component to the other and cannot therefore have descended from close-but-not-contact binaries satisfying the mass–luminosity relation. The possible formation and evolution of Lucy's (1967) contact configuration are considered. It is suggested that such a configuration evolves

on the nuclear time scale of the primary into a U Germinorum binary; losses of angular momentum in magnetically-coupled winds are probably too small to be important on this time scale. Some consequences of this evolutionary identification are explored for U Gem variables, particularly those that relate to the energy generation of the blue components in these systems. (auth)

49891 R. M. PETRIE'S OBSERVATIONS OF MU ORIONIS. Scarfe, C. D. (Univ. of Victoria, Can.). Publ. Astron. Soc. Pac., 79: 414-22(Oct. 1967).

Radial velocity observations of the triple system μ Orionis, obtained between 1957 and 1964, are presented. They indicate a small revision in the spectroscopic binary's period to $4^d.447622$ and provide tentative evidence for a small eccentricity. The velocities in the long-period orbit fall below those predicted from Bourgeois' elements but are insufficient to permit redetermination of the elements. (auth)

49892 DIAMETERS OF OPEN CLUSTERS. Lynds, Beverly T. (Univ. of Arizona, Tucson). Publ. Astron. Soc. Pac., 79: 448-55 (Oct. 1967).

The intrinsic diameters of the nine Trumpler classes of open clusters are reexamined. For unreddened or slightly reddened clusters, photometric data are used to find distances and intrinsic diameters of three Trumpler classes. An examination of reddened clusters of these classes indicates no systematic variation in the ratio of total to selective absorption with galactic longitude. Photometric distances and Trumpler's angular diameters are then used to calculate mean intrinsic diameters of the nine Trumpler classes. (auth)

49893 THE 1966 PALOMAR SUPERNOVA SEARCH. Zwicky, F. (Carnegie Institution of Washington, D. C. California Inst. of Tech., Pasadena). Publ. Astron. Soc. Pac., 79: 456-9(Oct. 1967).

Ten supernovae were found with the Palomar telescopes in 1966. A table is given and the galaxies are shown. (W.D.M.)

49894 HELIUM ABUNDANCE IN THE PROTO-GALAXY. van den Bergh, Sidney (Univ. of Toronto). Publ. Astron. Soc. Pac., 79: 460-3(Oct. 1967).

It is shown that at least two parameters are required to account for the observed range in the characteristics of globular cluster color–magnitude diagrams. Age differences between galactic globular clusters are negligible if they were all formed during the collapse of the proto-Galaxy. It is therefore suggested that both the helium abundance and the metal abundance differ from cluster to cluster. (auth)

49895 CLASSIFICATION OF EARLY M GIANT STARS BY INTERMEDIATE-BAND PHOTOMETRY OF THE 7050A TiO BANDS. Boyce, Peter B. (Lowell Observatory, Flagstaff, Ariz.); Olsen, Erik Heyn; Helt, Bodil E. Publ. Astron. Soc. Pac., 79: 473-81(Oct. 1967).

Spectra scans of the λ 7050 region were made of 47 stars ranging from K2 to M6. The digitized output of these scans was used to determine the parameters of an intermediate bandwidth photometric system for measuring spectral type. The final system appears to be a more sensitive indicator of spectral type and to have a fainter limiting magnitude than other systems so far proposed. (auth)

49896 NEW INTERPRETATION OF THE ANOMALOUS MICROWAVE RECOMBINATION LINE. Zuckerman, B.; Palmer, Patrick (Harvard Coll. Observatory, Cambridge, Mass.). Astrophys. J., 153: L145-9(Sept. 1968).

New observations were made of the anomalous microwave recombination line in the nebula NGC 2024. A new model is proposed in which the line originates in the outer parts of a dense H I region similar to that reported as a far-infrared nebula in Orion. The emitter is tentatively identified as carbon or, possibly, some other atomic or molecular constituent of the H I region having a comparable abundance. (auth)

49897 ULTRASHORT-PERIOD STELLAR OSCILLATIONS. II. THE PERIOD AND LIGHT CURVE OF HZ 29. Ostriker, Jeremiah P.; Hesser, James E. (Princeton Univ., N. J.). Astrophys. J., 153: L151-6(Sept. 1968).

The periodic variability, discovered by Smak, of the fourteenth-magnitude object HZ 29 was reinvestigated, using extensive new photoelectric data and modern autocorrelation analytical techniques. The variations, which have maintained a constant phase over at least a quarter of a year, allow to determine the period to high accuracy: 1051.118 ± 0.015 sec. Combining the observations using this period, a mean light curve is found having an amplitude of about 0.01 mag and the character of a double wave. These observations confirm this star as the shortest-period variable star for which a light curve is available. Although the nature of HZ 29 remains unclear, it seems increasingly unlikely that it is, as suggested by Burbidge, Burbidge, and Hoyle, a quasi-stellar object with large redshift. (auth)

49898 PROBLEMS OF INTENSE MAGNETIC FIELD IN GRAVITATIONAL COLLAPSE. Chiu, Hong-yee; Canuto, Vittorio (Inst. for Space Studies, Goddard Space Flight Center, N. Y.). Astrophys. J., 153: L157-61(Sept. 1968).

Questions have been raised as to whether a magnetic field may be destroyed by spontaneous pair creation. To answer this question and others, it is necessary to develop a quantum theory of matter in intense magnetic fields. In a series of papers the authors have studied the detailed properties of matter in intense magnetic fields. In this paper some results of astrophysical interest are discussed. Two cases are considered: (a) the magnetic moment of the electron is the Dirac moment $e\hbar/2$ mc and (b) in addition to the Dirac moment the electron also possesses a Schwinger anomalous magnetic moment $ae\hbar/4\pi mc$. When the field is of the order of 10^{16} gauss, the anomalous magnetic moment becomes important and must be taken into account. (W.D.M.)

49899 FAR-ULTRAVIOLET SPECTRAL INTENSITY OF A B3 V STAR. Opal, C. B. (Johns Hopkins Univ., Baltimore); Moos, H. W.; Fastie, W. G.; Bottema, M.; Henry, R. C. Astrophys. J., 153: L179-83(Sept. 1968).

A low-resolution, vacuum-ultraviolet spectrum of η Ursa Majoris was obtained with a scanning prism spectrometer in a pointed Aerobee rocket. Line blanketing appears to be considerably weaker than has been suggested in recent blanketed models. The absolute intensity is more than ½ mag below model predictions. An additional source of continuous opacity in the far ultraviolet may be needed to explain the discrepancy. (auth)

49900 TEMPERATURE OF THE QUIET SUN AT 2-CM WAVELENGTH USING THE MOON AS A STANDARD SOURCE. Buhl, David; Tlamicha, Antonin (National Radio Astronomy Observatory, Green Bank, W. Va.). Astrophys. J., 153: L189-90(Sept. 1968).

The temperature of the Sun on 2-cm wavelength was measured by using a high-resolution radio telescope with a half-power beam width (HPBW) of 2′. The radio temperature of the Moon was compared with that of the Sun. From this the temperature of the quiet Sun was found to be T = 9100° ± 600°K. (auth)

49901 INSTRUMENTAL RECALIBRATION AND REFINEMENT OF SOLAR ULTRASOFT X-RAY INTENSITIES. Manson, James E. (Air Force Cambridge Research Labs., Bedford, Mass.). Astrophys. J., 153: L191-3(Sept. 1968).

The monochromator flown on November 3, 1965, to measure the solar spectrum between 30 and 128 Å was recovered. This has permitted a recalibration using improved equipment and techniques. A correction factor that will improve the accuracy of the previously reported intensities (Manson) is presented. (auth)

49902 BLUE OBJECTS NEAR CEN X-2. Eggen, O. J. (Australian National Univ., Canberra); Lynga, G. Astrophys. J., 153: L195-7(Sept. 1968).

Positions and finding charts for blue objects near Cen XR-2 are provided. (auth)

49903 CAN THE REDSHIFTS OF QUASI-STELLAR OBJECTS BE GRAVITATIONAL? Zapolsky, Harold S. (Univ. of Maryland, College Park). Astrophys. J., 153: L163-9(Sept. 1968).

Recently, Hoyle and Fowler (1967) have proposed a model for the quasars in which the large, observed red shifts are explained as being chiefly gravitational in nature. Briefly, the model consists of a cluster of small, dense, and burned-out stars, with the emission line and continuum spectrum arising in a hot cloud of gas in the deep potential well in the center of the cluster. This model is discussed in some detail and it is concluded that, while general relativity allows one in principle to construct a cluster model of the Hoyle–Fowler type, the large central condensation implied by the theory makes it difficult to reconcile this model with either the observations or the most general ideas of the way in which star clusters evolve. (W.D.M.)

49904 TIME CHANGES IN THE STRUCTURE OF THE OPTICAL IMAGE OF 3C 287. Matthews, Thomas A. (Univ. of Maryland, College Park). Astrophys. J., 153: L171-7(Sept. 1968).

In the course of a program of high-resolution photography of identified radio sources, two plates were taken of 3C 287, one with the 100-inch telescope in 1965 and one with the 48-inch Schmidt telescope in 1966. The 48-inch plate shows nebulosity associated with the blue, star-like object that has been identified with the radio source, while the 100-inch plate gives some confirmation of this nebulosity. The plates suggest that, in addition

to the stellar components, there is also some nebulosity that has significantly changed in intensity in a period of one year. (W.D.M.)

49905 SPECTRUM OF NML CYGNUS FROM 2.8 TO 5.6 MICRONS. Gillett, F. C. (Univ. of California, San Diego, Kitt Peak National Observatory, Tucson, Ariz.); Stein, W. A.; Low, F. J. Astrophys. J., 153: L185-8(Sept. 1968).

Observations of the infrared spectrum of NML Cygnus were made from 2.8 to 5.6 μ with a resolution of approximately $\Delta\lambda/\lambda$ = 0.02. The object was observed twice, first in June 1967 and then with improved technique in June 1968. Both observations appear to indicate a possible weak absorption band at λ = 3.0 μ. Possible origins of such a band are discussed. (auth)

49906 SOFT X-RAYS FROM SCORPIUS X-1. Fritz, G.; Meekins, J. F.; Henry, R. C.; Byram, E. T.; Friedman, H. (Hulburt Center for Space Research, Washington, D. C.). Astrophys. J., 153: L199-202(Sept. 1968).

Proportional counter measurements from an Aerobee rocket launched on September 7, 1967, yielded an x-ray flux from Sco X-1 of 30^{+3}_{-10} keV keV^{-1} cm^{-2} sec^{-1} near 0.25 keV. An exponential extrapolation of the spectrum simultaneously observed in the range 1.5 to 13 keV predicts 32 $\pm$ 3 keV keV^{-1} cm^{-2} sec^{-1} at 0.25 keV. The apparent absorption corresponds to an optical thickness of 0.5 or less; with 1 hydrogen atom cm^{-3}, the source would be nearer than 25 pc. This discrepancy with other estimates of the distance could be resolved if a low-temperature plasma existed in the source or if the density of the interstellar medium were as low as 0.1 cm^{-3}. The latter would allow a description of the entire continuum output of Sco X-1 in terms of a characteristic temperature of 50 to 75 $\times$ 10^6°K. (auth)

49907 DIFFUSE NEBULAE. Osterbrock, Donald E. (Univ. of Wisconsin, Madison). Publ. Astron. Soc. Pac., 79: 523-45 (Dec. 1967).

A fairly extensive review is presented on the physics of diffuse nebulae. Several plates are included. (W.D.M.)

49908 DISTRIBUTION OF LONGITUDES OF PERIASTRON IN THE SIXTH CATALOGUE OF THE ORBITAL ELEMENTS OF SPECTROSCOPIC BINARY SYSTEMS. Batten, A. H. (Dominion Astrophysical Observatory, Victoria, British Columbia); Ovenden, Michael W. Publ. Astron. Soc. Pac., 70: 85-91(Feb. 1968).

The concentration of ω in the range 0 to 180° is present in the data of the Sixth Catalogue, being most pronounced for eclipsing systems with a large primary semi-amplitude, and a short period. The concentration to the first quadrant is most pronounced for stars with periods between 3 and 10 days. Other significant maxima occur at 0, 90, 210, and 270°, the incidence of these maxima among binaries of different categories being different among themselves and from the Barr effect. Attention is drawn to a sharp, statistically significant minimum at 250° which is common to almost all categories of binary in the catalog. (auth)

49909 ECLIPSING VARIABLE HD 35921. Mayer, Pavel (Univ. of Chicago. Charles Univ., Prague). Publ. Astron. Soc. Pac., 70: 81-4(Feb. 1968).

The sixth-magnitude O-type star HD 35921 has proved to be an eclipsing variable with period $4^d.0026$, large amplitude of light variations, and a double-line spectrum. (auth)

49910 ABSOLUTE DIMENSIONS OF CM LACERTAE. Barnes, Ronnie C. (Indiana Univ., Bloomington); Hall, Douglas S.; Hardie, R. H. Publ. Astron. Soc. Pac., 70: 69-80(Feb. 1968).

Photoelectric UBV observations of CM Lac were obtained, and the resulting three light curves were solved. It was decided that primary eclipse is definitely a transit. A few peculiarities were found in the blue light curve. The (B−V) and (U−B) indices correspond to spectral types A2 and A8. With Popper's new spectroscopic elements, the masses become 1.87 $M_\odot$ and 1.48 $M_\odot$, the radii 1.60 $R_\odot$ and 1.42 $R_\odot$, respectively. Thus, the system is found to consist of two rather normal main-sequence A stars. (auth)

49911 PHOTOELECTRIC OBSERVATIONS OF 4 CANUM VENATICORUM. Hayes, James E.; Heiser, A. Max (Vanderbilt Univ., Nashville). Publ. Astron. Soc. Pac., 70: 57-68 (Feb. 1968).

Photoelectric UBV and uvby observations were used to determine a primary period of $0^d.170934$ for the δ Scuti star 4 Canum Venaticorum. The variation of the amplitude in blue light was examined for a possible beat period. The uvby observations for 4 CVn showed a significant variation in c_1 but none in m_1. (auth)

49912 SPECTRUM OF GAMMA CASSIOPEIAE FROM A.D. 1911 TO 1966. Cowley, Anne P.; Marlborough, J. M. (Univ. of Chicago). Publ. Astron. Soc. Pac., 70: 42-5(Feb. 1968).

Two sets of spectrograms show the changes in the spectrum of γ Cassiopeiae from 1911 to 1940 and from 1940 to 1966, respectively. Important features are pointed out with references given to more detailed accounts. The unique present appearance of the spectrum is briefly discussed. (auth)

49913 SPECTRUM OF STAR NO. 1 IN NGC 2024. Garrison, R. F. (Carnegie Institution of Washington, D. C. California Inst. of Tech., Pasadena). Publ. Astron. Soc. Pac., 70: 20-4(Feb. 1968).

The spectrum of NGC 2024 No. 1 is identical to that of θ^2 Ori B (B0.5 Vp). A comparison of the photometry for the two stars gives a value for R of less than 4. The resulting absolute magnitude is consistent with the appearance of the spectrum. (auth)

49914 ACCURATE POSITIONS OF IDENTIFIED RADIO SOURCES. Bolton, J. G. (CSIRO, Sydney). Publ. Astron. Soc. Pac., 70: 5-15(Feb. 1968).

Accurate positions for the optical counterparts of 78 identified radio sources between declinations −33° and +20° were determined. The positions were measured with the new Gaertner proper motion machine at the Lick Observatory on plates taken with the Palomar 48-inch Schmidt telescope. (auth)

49915 RELATIONSHIP OF THE SMALL-DIAMETER RADIO AND OPTICAL FEATURES IN NGC 1068, NGC 1275, AND NGC 4486. Moffet, Alan T. (California Inst. of Tech., Pasadena). Publ. Astron. Soc. Pac., 70: 16-19(Feb. 1968).

NGC 1068, NGC 1275, and NGC 4486 are all relatively nearby galaxies possessing small-diameter radio and optical features which seem, on the basis of positional coincidence and similarity of size and shape, to be, related. The first two are Seyfert galaxies, and in them the radio features seem to be associated with the "Seyfert Nucleus." In the third, the radio feature is associated with the well-known jet. In addition both NGC 1275 and NGC 4486 have large-diameter radio source regions and are thus core–halo radio galaxies. (W.D.M.)

49916 OBSERVATIONS OF BLUE HARO GALAXIES. Dupuy, David L. (Wesleyan Univ., Middletown, Conn. Kitt Peak National Observatory, Tucson, Ariz.). Publ. Astron. Soc. Pac., 70: 29-36(Feb. 1968).

Radial velocities are obtained for four blue Haro galaxies. The absolute dimensions range from 2.0 to 6.8 kpc and absolute magnitudes range from −16.6 to −19.2. Internal velocity dispersions are about 100 km/sec. In Haro 2 and Haro 3, absorption lines show redshifts that differ from emission-line red shifts by about 400 km/sec in both senses. (auth)

49917 THE DIRAC-JORDAN HYPOTHESIS AND THE THERMODYNAMICS OF THE UNIVERSE. Treder, H.-J. (Forschungsgemeinschaft, Sternwarte Babelsberg, Ger.). Monatsber. Deut. Akad. Wiss. Berlin, 10: 69-74(1968). (In German).

The significance of the substitution of the generalized dynamic equation for the Einstein dynamic equation in the mathematical formation of the Dirac–Jordan hypothesis is discussed. The constant value of the photon number in this formulation is shown to be an effect of this formulation. (J.S.R.)

49918 RECENT STATISTICAL-EQUILIBRIUM MODEL-ATMOSPHERE CALCULATIONS FOR EARLY-TYPE STARS. Sampson, Douglas H. (Pennsylvania State Univ., University Park). Astrophys. J., 153: 1009-10 (Sept. 1968).

An improvement in the previous treatment of the non-LTE statistical mechanics appropriate for helium in early-type stars is presented. (auth)

49919 NUMERICAL EVALUATION OF ELECTRON-EQUATIONS OF STATE WITH PAIR CREATION. Herz, M. A.; Hansen, C. J. (Joint Inst. for Lab. Astrophysics, Boulder, Colo.). Astrophys. J., 153: 1011-13(Sept. 1968).

The method described by Divine to evaluate the ideal, partially degenerate equations of state for electrons was extended to the case where electron–positron pair creation is important. (auth)

49920 PHOTO-IONIZATION CROSS-SECTIONS FOR IONS OF CARBON, NITROGEN, OXYGEN, AND NEON. Hidalgo, Martin B. (Univ. of Colorado, Boulder). Astrophys. J., 153: 981-5(Sept. 1968).

Photo-ionization cross-sections are presented for C III, C IV, C V, N III, N IV, N V, O III, O IV, O V, Ne II, Ne III, Ne IV, and Ne V, as calculated by the screening theory, the quantum-defect method (where possible), and the hydrogenic approximation. These ions contribute to the opacity in the atmospheres of the central stars of planetary nebulae. (auth)

49921 ASTROPHYSICAL SIGNIFICANCE OF THE CONTINUOUS SPECTRUM OF THE HYDROGEN QUASI-MOLECULE. Doyle, Robert O. (Harvard Coll. Observatory, Cambridge, Mass.). Astrophys. J., 153: 987-96(Sept. 1968).

The importance of quasi-molecular hydrogen as a source of continuous absorption in stellar atmospheres is re-examined as a result of a recently revised calculation of this absorption coefficient that included the explicit dependence on the rotational state of the nuclei. At stellar temperatures, the detailed summation of the absorption coefficient over rotational states increases the strength by about a factor of 2 at short wavelengths. It is found that quasi-molecular hydrogen absorption is of maximum importance relative to other sources of opacity in dwarf stars along the main sequence at about solar temperature. In the solar case, it exceeds 1% of the total known opacity at wavelengths less than 3000 Å and generally contributes more than Rayleigh scattering and the negative hydrogen ion below about 2000 Å. The inclusion of quasi-molecular hydrogen absorption substantially reduces the disagreement between observed and calculated fluxes between 2000 and 1700 Å in the solar spectrum, and it contributes some opacity down to 1525 Å, a region that may include observable effects of the temperature minimum in the solar atmosphere (auth)

49922 THE MAGNESIUM ABUNDANCE IN THE B STARS. Hobbs, L. M.; Cowley, C. R. (Univ. of Chicago). Astrophys. J., 153: 909-14 (Sept. 1968).

A new value of the magnesium abundance in the B stars was calculated, based on the λ4481 doublet. Griem's value for the damping constant due to the quadratic Stark effect was used and quadrupole interactions were included. A simple expression is given for the parameter C_Q which enters into the formula for the quadrupole damping constant. The resulting magnesium abundance is in better accord with the solar value than earlier calculations indicated. Some attention is given to uncertainties in the calculation of the strength of λ4481 in the B stars due to microturbulence and the maximum line depth R_c. (auth)

49923 THE Ba II AND N STARS AS A TEMPERATURE SEQUENCE. Gordon, Courtney P. (Univ. of Michigan, Ann Arbor. Kitt Peak National Observatory, Tucson, Ariz.). Astrophys. J., 153: 915-16 (Sept. 1968).

The Ba II stars form a logical higher-temperature extension of the N stars on the basis of the observed strength of all spectral lines, and especially those of s-process elements. (auth)

49924 RADIATIVE TRANSFER. II. THE ITERATION OF THE MONOCHROMATIC SOURCE FUNCTION IN THE PRESENCE OF SCATTERING. Henyey, Louis (Univ. of California, Berkeley). Astrophys. J., 153: 917-22 (Sept. 1968).

The presence of scattering in an atmosphere necessitates, in its numerical study, the use of an iterative procedure to determine the source function. An expression due to Sobolev directly solves for the source function when the ratio of scattering to absorption is constant. The use of this formalism may be extended as the basis of a new iterative scheme, to the case when the ratio is variable with depth. (auth)

49925 LINE FORMATION WITH NON-COHERENT SCATTERING BY ELECTRONS. II. CALCULATIONS WITH MODEL ATMOSPHERES. Auer, Lawrence H.; Mihalas, Dimitri (National Bureau of Standards, Washington, D. C. Univ. of Colorado, Boulder). Astrophys. J., 153: 923-8 (Sept. 1968).

The effect of noncoherent scattering by electrons and atoms on line formation in early-type stars was studied using model atmospheres. Variability of the physical parameters was fully included. The effect of the non-coherency of the scattering by electrons is noticeable for a line like He II λ4200 but not for a much stronger one like He II λ4686. The solution in the core is dominated by the degree to which scattering (by atoms) occurs, while the wings are unaffected. The observed profile of He II λ4686 in 10 Lac can be fitted if the core of the line is deepened by scattering and broadened by rotation. (auth)

49926 SLOWLY ROTATING RELATIVISTIC STARS. II. MODELS FOR NEUTRON STARS AND SUPERMASSIVE STARS. Hartle, James B. (Univ. of California, Santa Barbara); Thorne, Kip S. Astrophys. J., 153: 807-34 (Sept. 1968).

The equilibrium configurations of rigidly rotating white dwarfs and neutron stars are calculated using the Harrison–Wheeler and the Tsuruta–Cameron V_γ equations of state, along with the general-relativistic equations of structure. The equations of structure used are the exact relativistic equations with one exception: they have been expanded in powers of the angular velocity Ω, and terms of higher order than Ω^2 have been neglected. The equilibrium configurations of slowly rotating supermassive stars are also calculated. (auth)

49927 HOT, VIBRATING NEUTRON STARS. Finzi, A. (Goddard Space Flight Center, N. Y.); Wolf, R. A. Astrophys. J., 153: 835-48 (Sept. 1968).

Taking into account the dissipative effect of neutrino-producing reactions, the amount of thermal and vibrational energy that can be present in a neutron star at a time t after its creation in a supernova explosion is calculated. The results are used to discuss the plausibility of a number of hypotheses advanced in recent years concerning possible observable properties of neutron stars. (auth)

49928 A NEW ENERGY–MOMENTUM TENSOR AND EXTERIOR SOLUTION FOR RADIATING SPHERES IN GENERAL RELATIVITY. Kaufmann III, William J. (Indiana Univ., Bloomington). Astrophys. J., 153: 849-54 (Sept. 1968).

A new energy–momentum tensor describing the radiation field outside a spherically symmetric distribution of matter is given. The field equations in Bondi's "radiation coordinates" are stated. At some point in space time outside the star, let Z be one-half of the angle subtended by the apparent disk seen by a freely falling observer who is momentarily at rest at that point. If the cosine of Z may be approximated by $(1 - \frac{1}{2}Z^2)$ with sufficient accuracy, then a simple analytical solution to the field equations exists which may be expressed by the metric $ds^2 = [1 + (2U^2/r^2) - (2W/r)]c^2du^2 + 2cdudr - r^2d\Omega^2$, where $d\Omega^2 = d\theta^2 + \sin^2\theta d\phi^2$, and U and W are functions of u (the timelike coordinate) only. U and W are related to the components of the radiation pressure and the flux in an elementary fashion. As soon as cos Z may no longer be approximated by $(1 - \frac{1}{2}Z^2)$, additional terms multiplying du^2 and dudr appear in the metric. These terms depend on the properties of the star in question, such as its mass, radius, and the structure of its atmosphere. A method for obtaining these additional terms is outlined. (auth)

49929 NEUTRON TUNNELING IN $^3He(^3He,2p)^4He$. May, Robert M.; Clayton, Donald D. (California Inst. of Tech., Pasadena). Astrophys. J., 153: 855-63 (Sept. 1968).

The possibility was investigated that in the astrophysically interesting energy range (i.e., well below the Coulomb barrier), the reaction $^3He(^3He,2p)^4He$ proceeds predominantly by a neutron-tunneling mechanism. Rough calculations of the magnitude and energy dependence of the total cross section and of the shape of the proton differential cross section were made on this basis. The results are in moderate agreement with recent experiments, and tend to justify a smooth extrapolation of these laboratory results down to the lower energies of astrophysical significance. (auth)

49930 EARLY-TYPE MAGNETIC STARS. Finzi, A. (Massachusetts Inst. of Tech., Cambridge); Wolf, R. A. Astrophys. J., 153: 865-75 (Sept. 1968).

The strong and rapidly varying magnetic fields observed in some early-type stars are probably derived from magnetic fields produced in the convective cores of these stars; a mechanism is suggested by which magnetic energy could be carried from the core of an early-type star to the surface. The action of the same mechanism could help to explain the chemical compositions of Ap and Am stars, the slow rotational velocities of magnetic stars, and the existence of "blue stragglers." The possibility that a significant fraction of galactic cosmic rays are produced in Ap and Am stars is discussed. (auth)

49931 THE LIGHT CURVES OF W URSAE MAJORIS STARS. Lucy, L. B. (Columbia Univ., New York). Astrophys. J., 153: 877-84 (Sept. 1968).

On the basis of a theory of the structure of W Ursae Majoris stars given in an earlier paper, a model for calculating their light curves is proposed. The most important feature of the model is the single, connected convection zone that forms the common envelope of the system. The model provides an explanation for the anomalous luminosity ratios of W UMa stars and correctly predicts the major characteristics of their light curves. A maximum of 1.28 mag for the depth of primary minimum in integrated light is also predicted and shown to be consistent with the observational data. However, the asymmetries in the light curves of many systems cannot be explained with this model. Furthermore, primary minimum for the theoretical light curves is due to the eclipse of the more massive component, which is not true for the majority of observed systems. (auth)

49932 RAPIDLY ROTATING STARS. IV. MAGNETIC WHITE DWARFS. Ostriker, Jeremiah P.; Hartwick, F. D. A. (Princeton Univ., N. J.). Astrophys. J., 153: 797-806 (Sept. 1968).

The self-consistent-field method of determining the equilibrium structure of a nonspherical star is extended to include an internal magnetic field. Models of white-dwarf stars are constructed that are uniformly rotating and contain fields that vanish at the surface. For the particular field configuration chosen, it is found that moderate internal fields can significantly increase the radii of white dwarfs while leaving their surface regions nearly spherical.

This provides an explanation for the observations that the radii of Sirius B, 40 Eri B, and a sample of white dwarfs investigated by Greenstein and Trimble are apparently somewhat larger than predicted by the classical mass–radius relations. (auth)

49933 INTERSTELLAR REDDENING FOR H II REGIONS AND LYMAN-VISUAL COLORS OF THEIR EXCITING STARS. Gebel, William L. (Univ. of Wisconsin, Madison). Astrophys. J., 153: 743-60 (Sept. 1968).

Photoelectric measures of total Hα and Hβ fluxes made through narrow-band interference filters with a 2-inch f/3.8 refractor are presented for 20 diffuse nebulae. The 6- and 11-cm radio-continuum fluxes of twelve of these nebulae obtained with the NRAO 140-foot telescope are also reported. The total extinction at Hβ derived from a comparison of the observed ratio of Hβ to radio fluxes with the theoretical ratio of recombination to free–free emissivities is combined with the nebular color excess deduced from the measured Balmer decrement to form the ratio of total to selective extinction. For the region of galactic longitude (l^{II}) 5° to 130°, the classical law of reddening, R = 3, is confirmed. A variation of R is found in the region 130° to 210° in qualitative agreement with the variation found from infrared stellar photometry; however, this conclusion is tentative because the observations for this region are the most uncertain. The reddening law for NGC 2244 is found to be normal, suggesting that the infrared excesses reported for the associated stars arise from an emission process rather than from an anomalous reddening law. The temperature dependence of the theoretical ratio of emissivities leads to an electron temperature of 6000°K or less for H II regions. A color between the Lyman continuum and the visual for the exciting stars is derived by the Zanstra technique, using the radio fluxes measured for this study as well as previous measurements. It is shown how these colors can be used to establish a spectral-type–effective-temperature relation for the early O stars when line-blanketed model atmospheres become available. (auth)

49934 THE COLOR–MAGNITUDE DIAGRAM FOR THE ABNORMALLY STRONG-LINE GLOBULAR CLUSTER M69. Hartwick, F. D. A.; Sandage, Allan (Carnegie Institution of Washington, D. C. California Inst. of Tech., Pasadena). Astrophys. J., 153: 715-22 (Sept. 1968).

A color–magnitude diagram for the Morgan class VII cluster M69 (NGC 6637) was obtained using a provisional magnitude sequence transferred from NGC 6356. The stubbiness of the horizontal branch and the magnitude rise of the giant sequence is similar to 47 Tuc. The parameters ΔV and $(B-V)_{0,g}$ indicate that the cluster may be even slightly more metal-rich — a conclusion consistent with the difference in spectral type: G5 (M69) and G3 (47 Tuc). The true distance modulus is $(m-M)_0 = 15.2 \pm 0.5$, corresponding to a distance from the Sun of 11 kpc and a height above the galactic plane of 2.1 kpc. The absolute magnitude and linear diameter are $M_v = -8.1$ and D = 22 pc, respectively. It is doubtful whether an RR Lyrae variable found near the cluster by Rosino is a cluster member, but the membership of four long-period variables near the top of the giant branch seems certain. M69 extends the tight correlation between ΔV and $(B-V)_{0,g}$ toward higher metal abundances than have been heretofore available. The correlation is in good qualitative agreement with the prediction of Demarque and Geisler on the effect of variable metal abundance on the shape of globular-cluster, giant branches. (auth)

49935 STELLAR-POPULATION SAMPLES AT THE GALACTIC POLES. I. PROPER-MOTION STARS, BLUE OBJECTS, AND ECLIPSING BINARIES NEAR THE SOUTH POLE. Eggen, O. J. (Australian National Univ., Canberra). Astrophys. J., 153: 723-36 (Sept. 1968).

This is the first in a series of papers that will present accurate photometric data for large samples of objects, with various characteristics, located near the galactic poles. Photometry on the UBV system for the 130 stars of the Bruce Proper Motion Survey within about 3° of the south pole is discussed with reference to the ultraviolet excess and the space motions of the stars. A smaller sample of brighter stars has been observed on the (u,v,b,y) system, and the results show clearly the value of this system in population studies. Faint blue stars within 10° of the south pole have been observed on the UBV system, and their distribution in the (U – B, B – V)-plane is discussed. Also, an attempt to find horizontal-branch stars of the halo population among high-latitude eclipsing binaries has turned up several candidates. (auth)

49936 ATTEMPTS TO DETECT RADIO EMISSION FROM TWO GALACTIC X-RAY SOURCES. Moffet, A. T.; Berge, G. L. (California Inst. of Tech., Pasadena). Astrophys. J., 153: 997-9 (Sept. 1968).

Two galactic x-ray sources identified with stellar objects, Sco X-1 and Cyg X-2, were observed at centimeter wavelengths. No emission was found from Sco X-1 above the limits set by noise and confusion, but a weak radio source may have been detected in the position of Cyg X-2. These observations are in conflict with the hypothesis that the entire continuum emission from such objects is bremsstrahlung from a hot plasma. (auth)

49937 POLARIZATION OF STRONG RADIO SOURCES AT 9.55-MM WAVELENGTH. Hobbs, Robert W. (Naval Research Lab., Washington, D. C.). Astrophys. J., 153: 1001-2 (Sept. 1968).

The polarization of five strong radio sources, 3C 84, Tau A, Orion A, 3C 273, and Jupiter, was measured at 9.55 mm using the 85-foot paraboloidal reflector at the NRL. The results show only Tau A to be polarized to a significant degree. (W.D.M.)

49938 TIME VARIATIONS IN SCORPIUS X-1 AND CYGNUS X-1. Overbeck, James W.; Tananbaum, Harvey D. (Massachusetts Inst. of Tech., Cambridge). Astrophys. J., 153: 899-908 (Sept. 1968).

In a series of balloon flights in May and June 1967 significant time variations were found in the x-ray fluxes above 15 keV from Scorpius X-1 and Cygnus X-1. On June 26–27 the fluxes measured for Scorpius X-1 in energy bands from 16.6 to 23.4 and 23.4 to 30.3 keV agreed with those measured by Peterson and Jacobson in June 1965 and were 2.3 and 2.8 times those measured for the same bands on May 16. On June 26–27 the flux from Scorpius X-1 between 23.4 and 46.7 keV was 2 times the flux observed for this band on May 25. From Cygnus X-1 on June 27 a flux between 23.4 and 46.7 keV was found that was a factor of 2.6 lower than the flux found on May 25. It had already been found that the flux in this energy band during the two May flights was 2.3 times higher than the flux observed in September 1966. A positive flux was observed from the Sagittarius region and upper limits were found for Cygnus X-3, Cygnus X-2, Serpens X-1, M87, and Cassiopeia A. (auth)

49939 ANALYSIS OF X-RAY SPECTRA. Gorenstein, P. (American Science and Engineering, Inc., Cambridge, Mass.); Gursky, H.; Garmire, G. Astrophys. J., 153: 885-97 (Sept. 1968).

As x-ray spectral information obtained from celestial objects improves in statistical accuracy, it is clear that the methods used to analyze these spectra must include the detailed interaction between the radiation field and the detector. A systematic method of analysis of proportional-counter x-ray data is presented. The analysis program is used to analyze x-ray spectral observations of Sco X-1 which were made on March 8, 1966, and October 11, 1966, using gas-filled proportional counters. The observed spectra are found to fit an optically thin plasma (Gaunt factor = 1) with $T = 10 \pm 0.7 \times 10^7$ °K for the March flight and a similar plasma at $T = 5.7 \pm 0.5 \times 10^7$ °K for the October flight. The March flight data also are found to fit Tucker's Models 2 and 3 with temperatures of about $8 \pm 0.5 \times 10^7$ °K and $5.6^{+1.0}_{-0.7} \times 10^7$ °K, respectively, while the October flight also fits a model proposed by Manley with an energy parameter of $6.0^{+1.0}_{-0.4}$ keV. (auth)

49940 THE STRUCTURE AND PROPERTIES OF H II REGIONS. Rubin, Robert H. (Case Western Reserve Univ., Cleveland). Astrophys. J., 153: 761-82 (Sept. 1968).

The equations of ionization and thermal equilibrium are solved for gaseous nebulae, allowing for an arbitrary density distribution. It is shown, by solving the transfer equation for the ionizing radiation produced by recombinations, that use of the "on-the-spot" approximation (Zanstra) can cause considerable errors in the temperature structure (up to ~2000°K near the nebular center) and predicted emission properties. In some cases, certain of the far-infrared forbidden lines of the cooling ions undergo considerable self-absorption. The implications of optical thickness for two of these lines, [O III] λλ88 and 52 μ, are considered by solving the problem of line transfer. It is found that under certain conditions electron temperatures may be raised by up to 500 to 1000°K. The inclusion of density fluctuations is found to reduce drastically the ionized region and to raise somewhat the electron temperatures, all other parameters of the model being the same. Changes in the gas structure due to variations of the model parameters are investigated. For the models calculated, the emission properties of the important lines are presented. (auth)

49941 TRANSFER OF LYMAN ALPHA IN DIFFUSE NEBULAE. Auer, Lawrence H. (Princeton Univ., N. J.). Astrophys. J., 153: 783-96 (Sept. 1968).

The Monte Carlo method is applied to the solution of the transfer equation for Ly-α radiation in nebulae with optical thicknesses up to 10^5. Plane-parallel geometry, two-level atoms, and constant temperature are assumed. The correlation between the direction of scattering and the frequency redistribution is taken into account

exactly. A method is developed for accelerating the solution by treating the line core analytically and using the Monte Carlo method only in the wings. It is found that for Doppler broadening the assumption of complete redistribution is a reasonably satisfactory approximation. The mean number of scatterings before escape is on the order of τ_0. For lines with finite natural width, the presence of Lorentz wings, where scattering tends to be coherent, reduces the mean number of scatterings from the case with zero natural width. This effect is seen only after the optical depth at line center has become great enough that the nebula is opaque at all frequencies in the core. The emergent flux has a double-humped frequency distribution. When the ratio of the natural width to the Doppler width is increased, the width of the emergent line is also increased. For density-bounded H II regions with optical thickness at the line center of 10^5, illuminated by an incident Lyman-continuum flux, the energy density in Ly-α does not rise to more than twenty-five times the energy density of the incident continuum radiation. Radiation pressure from Ly-α does not become large enough to have dynamical effects. Two-photon emission is negligible, but if the grain density within the H II region is as high as it is in interstellar space, almost all Ly-α photons will be absorbed before they can escape. (auth)

49942 HIGH-RESOLUTION OBSERVATIONS OF SMALL-DIAMETER RADIO SOURCES AT 18-CENTIMETER WAVELENGTH. Clark, B. G. (National Radio Astronomy Observatory, Green Bank, West Va.); Kellermann, K. I.; Bare, C. C.; Cohen, M. H.; Jauncey, D. L. Astrophys. J., 153: 705-14 (Sept. 1968).

A long base-line interferometer was operated at 18 cm over an 845-km (4.7×10^6 λ) base line between the NRAO 140-foot radio telescope of Green Bank, West Virginia, and the 120-foot telescope at the Haystack Microwave Facility near Boston, Massachusetts. Independent rubidium-controlled atomic clocks were used as time and frequency standards at each telescope. The intermediate-frequency signals from each antenna were recorded on magnetic tape and later correlated in a digital computer. Reliable data were obtained for twenty-eight sources. Eleven appear unresolved and are therefore less than 0".01 to 0".02 in diameter. Four others have components that contain a significant fraction of the total flux in a component less than this size; and two others are completely resolved and thus do not contain significant small-scale structure. The ten partially resolved sources have angular dimensions of the order of a few hundredths of a second of arc. Comparison of the radio-frequency spectra with interferometer measurements made at several wavelengths indicates that many sources consist of a number of well-defined, small-diameter components, each of which has a diameter independent of wavelength. The magnetic field deduced from the low-frequency cutoff in the radio spectra is of the order of 10^{-4} gauss in the partially resolved components. (auth)

49943 ATOMIC SOLAR LINES IN THE REGION 1 TO 2 μ OBSERVED FROM A BALLOON-BORNE SPECTROMETER. Goldman, A.; Murcray, D. G.; Murcray, F. H.; William, W. J. (Univ. of Denver, Colo.). Astrophys. J., 153: 1007-8 (Sept. 1968).

It has been expected for many years that a number of infrared solar lines could be detected if the masking effects due to telluric lines were eliminated. Successful detection of such lines became possible with the data obtained during a balloon flight made in the summer of 1967. The variation with altitude of the infrared solar spectrum was observed with a resolution of 0.50 Å. On many of the spectra from this flight, it was possible to identify a number of multiplets in the region 1 to 2 μ that have been previously masked. The identification of the lines was based on matching both the intensities and the positions. (W.D.M.)

49944 MAGNETOGRAPH OBSERVATIONS OF THE QUIET SUN. I. SPATIAL DESCRIPTION OF THE BACKGROUND FIELDS. Livingston, W. C. (Kitt Peak National Observatory, Tucson, Ariz.). Astrophys. J., 153: 929-42 (Sept. 1968).

A photoelectric magnetograph is described which achieves an rms noise equivalent sensitivity of 1 gauss (arc sec)$^{-2}$ sec^{-1}. The dynamic range is 0.5 to 4000 gauss. Fine-scan maps of the center of the disk, 45000 × 52000 km, show Ca^+ K-emission associated fields of ~100 gauss and background fields of ~10 gauss. Both the K-emission fields and background fields resolve into elements of about the same size 1000 to 2000 km, when measured at the half-intensity point. The integrated flux contained in the background fields was never zero (1965 to 1967) but ranged from 0.25 to 0.5 of the flux in the K-emission elements. The background fields are suggested to be remnants of old K-emission fields reduced in strength, but not size, by the action of the supergranulation. Previously reported upper limits to a granular magnetic field probably represent measures of these relatively large supergranule-related elements. Single line scans made with an aperture of 360 × 360 km achieve an effective resolution of 500 km when the seeing is good. While velocity and brightness elements in the quiet Sun exhibit a spatial fine structure down to this observational resolution limit, no similar fine structure is found in magnetic fields. (auth)

49945 ANGULAR MOMENTUM OF THE SOLAR WIND. Schubert, Gerald; Coleman, Paul J. Jr. (Univ. of California, Los Angeles). Astrophys. J., 153: 943-50 (Sept. 1968).

The flux of angular momentum associated with low-frequency plasma fluctuations in the solar wind is considered. The transverse Alfvén waves, for which there are no fluctuations in the density, exert an apparent torque on the solar-wind plasma that is in the direction to increase the corotation of the solar wind but is negligible compared with the torque exerted by the mean magnetic field. On the other hand, waves that possess density fluctuations, such as the fast magnetosonic mode of linearized magnetohydrodynamics, can contribute a flux of angular momentum that is comparable to the mean torque exerted on the solar wind. This contribution is proportional to the product of the mean solar-wind density, the mean radial velocity, the square of the Alfvén speed, and the mean square of the density fluctuations divided by the square of the mean density. (auth)

49946 LABORATORY OBSERVATION OF A VISIBLE EMISSION LINE OF HIGHLY IONIZED ARGON AT 4412 A. Conrads, H.; Oertel, G. K. (Langley Research Center, Hampton, Va.). Astrophys. J., 153: 975-80 (Sept. 1968).

An effort was made to observe the coronal emission line at 4412 Å in an argon–deuterium plasma produced by a 600-kJ theta pinch. An emission line at 4412 Å is observed whenever the plasma reaches the required high temperature, as indicated by, for example, photographic observation of Ar XIII lines. At the time of peak emission, an electron density of 10^{17} cm^{-3} was measured. Assuming the identity of the observed 4412 Å line with the $^2P_{\frac{3}{2}} - {}^2P_{\frac{1}{2}}$ transition (Ar XIV), the ratio of line intensity to bremsstrahlung intensity indicates a transition probability of at least four times the value predicted by calculations for the magnetic dipole transition (in [Ar XIV]). (auth)

49947 THE STRENGTH OF Hβ IN EXTRAGALACTIC OBJECTS WITH BROAD EMISSION LINES. Searle, Leonard (Australian National Univ., Canberra); Sargent, Wallace L. W. (Astrophys. J., 153: 1003-6 (Sept. 1968).

It is pointed out that the equivalent width of the Hβ emission line in extragalactic objects with broad Balmer emission lines is always less than the value expected from recombination theory by about the same large factor. This can be understood if the following conditions are satisfied: (a) the gas in all these objects is ionized by nonthermal radiation, (b) in all the objects the nonthermal radiation has roughly the same spectral index, and (c) this value of the spectral index persists below the Lyman limit. (auth)

49948 A STATISTICAL MODEL OF INTERSTELLAR CLOUDS. II. EFFECT OF VARYING CLOUD CROSS SECTIONS AND VELOCITIES. Field, George B.; Hutchins, John (Univ. of California, Berkeley). Astrophys. J., 153: 737-42 (Sept. 1968).

A new derivation of the mass spectrum of interstellar clouds, which includes the variation of cross section and speed with cloud mass, is presented. In the particular case in which the rate of star formation is very low, the calculated spectrum is quite similar to that found in a previous paper (about $m^{-\frac{5}{2}}$), taking the cross section and speed to be independent of mass. Some recent observations agree rather well with the calculated spectrum, while others are at variance with it. (auth)

49949 EVIDENCE FOR GALACTIC MAGNETIC FIELDS. Davis, Leverett Jr.; Berge, G. L. (California Inst. of Tech., Pasadena). pp 755-70 of Nebulae and Interstellar Matter. Middlehurst, Barbara M. (ed.). Chicago, University of Chicago Press, 1968.

The basic principles involved in proving the existence of the galactic magnetic field are considered. Synchrotron radiation, Faraday rotation, and the Zeeman effect are discussed. Interstellar polarization of starlight is briefly reviewed and other indirect arguments are pointed out. (W.D.M.)

49950 PRIMORDIAL STELLAR EVOLUTION. Upton, E. K. L. (Univ. of California, Los Angeles). pp 771-824 of Nebulae and Interstellar Matter. Middlehurst, Barbara M. (ed.). Chicago, University of Chicago Press, 1968.

Topics discussed include contraction with radiative transport, conditions for homologous contraction, results for homologous contraction, nonhomologous contraction and thermal relaxation, Hayashi's theorem and convective transport, results for convective transport, pre-main-sequence nuclear reactions, and thermodynamic collapse. (W.D.M.)

49951 HIGH-TEMPERATURE COMPONENT OF CEN XR-2. Manley, O. P. (American Science and Engineering, Cambridge, Mass.). Nature (London), 219: 1236-7 (Sept. 21, 1968).

It has been suggested that the discovery in Cen XR-2 of a high temperature component with a decreasing intensity may be consistent with the proposed nova-like model of Chodil et al., and this component may have arisen as the shock from the nova expanded into a circumstellar medium of radially decreasing density. It was assumed explicitly that the energy in the shock is constant; this, however, need not be true for at least two reasons. The proposed model requires a continuous, but not constant, heating mechanism to maintain the observed nearly isothermal radiation; and at the observed temperatures radiative losses in the shock itself are not negligible. Once radiative losses become significant the shock cannot be treated as adiabatically insulated. It is therefore obvious that the theory of shock heating of the interstellar medium following a nova explosion must be augmented by accounting for radiation losses if it is to serve as a basis for models of transient x-ray stars such as Cen XR-2. Properties of the hot source in relation to the cool source are discussed. The influence of a magnetic field is also considered; also implications of a study of Cen XR-2 to a better understanding of the interstellar medium in the vicinity of a nova and possibly to a solution of the problem of mass loss in the prenova stage. (UK)

49952 DIFFUSE NEBULAE. Johnson, Hugh M. (Lockheed Research Lab., Palo Alto, Calif.). pp 65–118 of Nebulae and Interstellar Matter. Middlehurst, Barbara M. (ed.). Chicago, University of Chicago Press, 1968.

Reflection nebulae are discussed in terms of the Pleiades and NGC 7023. Topics considered under emission nebulae include the bright-line spectrum of NGC 1976, the bright-line spectra of other diffuse nebulae, the continuous spectrum, forms and structural features, radial velocities, and emission nebulae in external galaxies. (W.D.M.)

49953 DYNAMICS OF INTERSTELLAR MATTER AND THE FORMATION OF STARS. Spitzer, Lyman Jr. (Princeton Univ., N. J.). pp 1–63 of Nebulae and Interstellar Matter. Middlehurst, Barbara M. (ed.). Chicago, University of Chicago Press, 1968.

The evidence on star formation, which is based on the study of the stars themselves and not on any properties of the interstellar medium, is reviewed. The observational evidence on the structure of the interstellar medium and on the observed motions of the gas, the rudimentary theory of these motions, and the possible mechanisms by which gas is compressed into clouds and clouds into protostars and stars are discussed. (W.D.M.)

49954 NEBULAE AND INTERSTELLAR MATTER. Middlehurst, Barbara M.; Aller, Lawrence H. (eds.). Stars and Stellar Systems. Volume VII. Chicago, University of Chicago Press, 1968. 855p. $27.50; 12 £.

Work at radio, x-ray, uv, and infrared wavelengths is reviewed. Theoretical chapters and surveys of direct observations of bright and dark nebulae, planetary nebulae, and interstellar grains are included, as well as chapters on cosmic rays, star formation, flare stars, nonthermal sources, synchrotron radiation, galactic magnetic fields, interstellar extinction, and interstellar lines. Separate abstracts were prepared for the 16 chapters. (W.D.M.)

For abstracts of individual papers see: 49949, 49950, 49952, 49953, 49955–49965, and 50063.

49955 DARK NEBULAE. Lynds, B. T. (Univ. of Arizona, Tucson). pp 119–39 of Nebulae and Interstellar Matter. Middlehurst, Barbara M. (ed.). Chicago, University of Chicago Press, 1968.

The early history of dark markings is briefly discussed and catalogs of dark nebulae are considered. The distribution of dark nebulae is discussed in terms of distances and galactic distribution. The physical properties of nebulae are covered as to size, shape, globules, masses, and densities. (W.D.M.)

49956 FLARE STARS. Haro, G. (Tonantzintla Observatory, Mexico). pp 141–66 of Nebulae and Interstellar Matter. Middlehurst, Barbara M. (ed.). Chicago, University of Chicago Press, 1968.

Flare stars are considered under two headings without implying any conclusion about flare production mechanism in the two groups. These groups are (a) flare stars in stellar aggregates and the solar vicinity including stars of the UV Ceti type in the general field, and (b) binary stars of the U Gem and W Ursa Major types, novae and related objects, and Andrews' star. Flare stars of the first group are dealt with primarily. (W.D.M.)

49957 INTERSTELLAR EXTINCTION. Johnson, H. L. (Univ. of Arizona, Tucson). pp 167–220 of Nebulae and Interstellar Matter. Middlehurst, Barbara M. (ed.). Chicago, University of Chicago Press, 1968.

Three methods of investigating the characteristics of interstellar extinction are considered. Each provides only a part of the information desired. It is seen, however, that a combination of the results from the several methods provides fairly complete information about interstellar reddening and extinction. (W.D.M.)

49958 INTERSTELLAR GRAINS. Greenberg, J. Mayo (Rensselaer Polytechnic Inst., Troy, N. Y.). pp 221–364 of Nebulae and Interstellar Matter. Middlehurst, Barbara M. (ed.). Chicago, University of Chicago Press, 1968.

Topics discussed include observational evidence for grains, general formulation of the theory of extinction and polarization by grains, physical and chemical properties of the interstellar medium, physics and chemistry of grains, orientation mechanism, grain optics, interpretations of interstellar extinction and polarization, reflection nebulae, and diffuse interstellar lines. (W.D.M.)

49959 INTERSTELLAR ABSORPTION LINES. Muench, Guido (Carnegie Institution of Washington, D. C. California Inst. of Tech., Pasadena). pp 365–402 of Nebulae and Interstellar Matter. Middlehurst, Barbara M. (ed.). Chicago, University of Chicago Press, 1968.

Data of observations are discussed as to identification, catalogues, and structure of the interstellar lines. Methods of analysis are covered in terms of curves of growth for single clouds, the doublet-ratio method, curves of growth for more than one cloud, statistical curve of growth, ionization equilibrium in space, and excitation in interstellar space. Interpretation of observations is discussed under the doublet-ratio method, intensity–distance relations, mean space densities of Ca II and NaI, correlation between interstellar live strengths and reddening, intercloud medium, chemical composition of the gas, and high-velocity clouds. (W.D.M.)

49960 ATOMIC PROCESSES WITH SPECIAL APPLICATION TO GASEOUS NEBULAE. Czyzak, S. J. (General Physics Research Lab., Wright-Patterson AFB, Ohio). pp 403–82 of Nebulae and Interstellar Matter. Middlehurst, Barbara M. (ed.). Chicago, University of Chicago Press, 1968.

The theory for calculating wave functions, transition probabilities, and collision cross sections is described. In addition, an example shows the mathematical manipulations involved in such calculations. The ion Fe XVI was chosen for this purpose because its relatively simple electronic configurations ($1s^22s^22p^63s$) simplified the calculations for the wave functions, transition probabilities, and collision cross sections without detracting from the demonstration of the general procedure for such computations. Results obtained and existing problems are discussed. (W.D.M.)

49961 PLANETARY NEBULAE. Aller, L. H. (Univ. of California, Los Angeles); Liller, William. pp 483–574 of Nebulae and Interstellar Matter. Middlehurst, Barbara M. (ed.). Chicago, University of Chicago Press, 1968.

Planetary nebulae are discussed in terms of distances, methods of observation, origin of spectra, the primary mechanism (recombination lives of H and He), thermal balance, forbidden lines (electron temperatures and densities), continuous spectra, radio-frequency emission, chemical composition, central stars, structure, magnetic fields, and internal motions. (W.D.M.)

49962 RADIO-LINE EMISSION AND ABSORPTION BY THE INTERSTELLAR GAS. Kerr, F. J. (CSIRO, Sydney). pp 575–622 of Nebulae and Interstellar Matter. Middlehurst, Barbara M. (ed.). Chicago, University of Chicago Press, 1968.

Physical processes and observational results as they relate to the properties of the interstellar gas and its small-scale structure are covered in a discussion on excitation of the H and OH lines, formation of emission and absorption lines, observational techniques, observational results (H and OH), physical properties of the gas, correlation with other Population-I constituents, and other line possibilities. (W.D.M.)

49963 NONTHERMAL GALACTIC RADIO SOURCES. Minkowski, R. (Univ. of California, Berkeley). pp 623–66 of Nebulae and Interstellar Matter. Middlehurst, Barbara M. (ed.). Chicago, University of Chicago Press, 1968.

At this time supernova remnants are the only objects established as galactic nonthermal sources. Topics covered in this review include thermal emission and absorption, nonthermal emission, supernovae, remnants of observed supernovae, Cassiopeia A, supernovae of Type II, and old supernova remnants. (W.D.M.)

49964 THEORY OF SYNCHROTRON RADIATION. Bless, R. C. (Univ. of Wisconsin, Madison). pp 667–84 of Nebulae and Interstellar Matter. Middlehurst, Barbara M. (ed.). Chicago, University of Chicago Press, 1968.

The theory of synchrotron radiation is discussed in terms of the total power radiated, angular and spectral distributions of the radiation, polarization, and quantum effects. Topics discussed

under astrophysical application include radiation from a single electron, synchrotron radiation from an assemblage of electrons, determination of the energy in the particles and in the magnetic field, energy losses by other processes, and the Crab Nebula. (W.D.M.)

49965 DISCRETE X-RAY SOURCES. Friedman, Herbert (Naval Research Lab., Washington, D. C.). pp 685-706 of Nebulae and Interstellar Matter. Middlehurst, Barbara M. (ed.). Chicago, University of Chicago Press, 1968.

X-ray astronomy is reviewed under the following topics: early observations, x-ray emission mechanisms, occultation of the Crab Nebula, cosmic x-ray surveys, distribution of x-ray sources, the Crab Nebula, Sco XR-1, and extragalactic sources. (W.D.M.)

49966 POSITIVE DETERMINATION OF AN INTERSTELLAR MAGNETIC FIELD BY MEASUREMENT OF THE ZEEMAN SPLITTING OF THE 21-cm HYDROGEN LINE. Verschuur, G. L. (National Radio Astronomy Observatory, Green Bank, W. Va.). Phys. Rev. Lett., 21: 775-8(Sept. 9, 1968).

Fields of the order of 2×10^{-5} G exist in the Perseus spiral arm in the direction of the radio source Cassiopeia A. (auth)

49967 IS GRAVITATION MODIFIED BY TIME? Gamow, G. (Univ. of Colorado, Boulder). Sciences (Paris), No. 53, 29-32 (Jan.-Feb. 1968). (In French).

Dirac's hypothesis concerning decrease of gravitational forces is demonstrated by consideration of the history of the Sun. The nuclear reactions of the carbon cycle and the proton–proton cycle are used to define constants interrelating equations of state, of hydrostatic equilibrium, of conservation of mass, of energy transport by radiation, of energy transport by convection, and of energy production by a set of homologous transformations. Luminosity is shown to be related to mass through dependence on the cycle (H–H) or (C–N) predominating in the particular star. Using a constant of gravitation which is an inverse function of time, the Sun is shown not to have had sufficient fuel for the production of intense, persistent luminosity at its origin, as Dirac's theory would have proposed. (BBB)

49968 STELLAR EVOLUTION. Tayler, R. J. (Univ. of Sussex, Brighton, Eng.). Rep. Progr. Phys., 31: 167-223(1968).

Direct observation of the evolution of most stars seems impossible. Typically evolutionary time scales are between 10^8 and 10^{10} years. Despite this, studies of stellar evolution have progressed considerably. On the observational side it has been realized that, although the classification of stars into groups with similar properties is very useful, these groups are not exclusive and any star in its full life history may be a member of several. In addition, physical groupings of stars exist in which the main difference between stars is almost certainly their mass, while there are less important differences in age and chemical composition. Massive stars evolve more rapidly than low-mass stars, and study of star clusters gives information about stellar evolution. Theoretical studies of stellar evolution have been stimulated by the development of large computers capable of solving the full equations of stellar structure, with no important physical processes neglected. These calculations have followed stars in a wide mass range through a large fraction of their life history. The results have been compared with observations and there is at least a good qualitative agreement. There are important detailed discrepancies between theory and observation, and there are stages of stellar evolution which have not yet been reached by the calculations. One very important uncertainty in present theoretical studies is the role of large-scale instabilities such as mass loss. A discussion is presented of the results of recent theoretical calculations including comparison of these results with observation. A brief description is given of the equations of stellar structure and the physics of stellar interiors, but no account of the way in which these equations are solved. Most of the discussion is qualitative rather than quantitative, with the emphasis on presenting the main ideas of the subject rather than the precise results of the latest calculations. (auth) (UK)

49969 RELATIVISTIC COSMOLOGY. Griffin, Nicholas (Univ. of Leicester, Eng.). Sci. Progr., (London), 56: 371-87 (Autumn 1968).

Although nonEuclidean geometry was originally of interest only to mathematicians, with the advent of general relativity it became of great use in understanding the geometry of the Universe. General relativity enabled Einstein to replace the inadequate Newtonian world-model with the first of a series of relativistic models, though only at the cost of the addition of the cosmological constant to the field equations. This addition was found unnecessary by the discovery of a redshift, which had already played a part in de Sitter's empty world model. By considering the implications of the redshift, together with measurements of the average density of matter in the visible Universe, the rate of expansion of the Universe and the nature of its geometry can be found. So far measurements have been insufficiently exact for unequivocal answers to these problems. This paper is intended as an elementary introduction to the subject. (auth) (UK)

49970 HIGH-ENERGY X RAYS FROM CEN XR-2. Lewin, W. H. G.; Clark, G. W.; Smith, W. B. (Massachusetts Inst. of Tech., Cambridge). Nature (London), 219: 1235-6(Sept. 21, 1968).

Two high energy x-ray sky surveys were carried out in balloon flights from Mildura, Australia, on October 15 and 24, 1967, which included observations of Centaurus XR-2. The present communication is concerned with the spectrum and intensity of the source as derived from data recorded when the detector axis was within 12° of the source. The total accumulated effective exposure in 19 scans over the source was 1.6×10^5 cm^{2}s. The spectral data are tabulated. The high energy x-ray flux on October 15th was $\sim 4 \times 10^{-9}$ ergs cm^{-2}s^{-1} from 20 to 52 keV and $\sim 2.7 \times 10^{-9}$ from 52 to 105 keV, and the measured rate of change in the energy intensity from 20 to 52 keV was $35 \pm 17\%$ in 9.8 days. Comparisons are made with some earlier rocket results, and explanations for discrepancies are suggested. The most likely position of the source was found to be $\alpha = \sim 197°$, $\delta = \sim -64°$. (UK)

49971 CORRECTED DISPERSION VALUES FOR CP 0808, CP 0328, AND HP 1506. Cole, T. W. (Cambridge Univ., Eng.). Nature (London), 219: 1238(Sept. 21, 1968).

Errors in the paper by Cole and Pilkington published in Nature, 219: 574 (1968) are pointed out. These were due to errors in the measurement of the cable lengths which determined the dispersion. Corrected values are given for frequency sweep, integrated electron density, and distance. The amended distance values, however, do not alter the conclusion that the sources are within the galactic distribution of ionized hydrogen. (UK)

49972 NEW PULSAR IN VULPECULA. Craft, H. D.; Sutton, J. M.; Comella, J. M. (Arecibo Ionospheric Observatory, Puerto Rico). Nature (London), 219: 1237-8(Sept. 21, 1968).

A second pulsar was discovered in the constellation Vulpecula on Aug. 26, 1968, after a new digital reduction program was applied to 111.5-MHz pulsar search data. Some characteristics of this new pulsar are tabulated. The pulsar shows features common to other known pulsars. Observations indicate that it has a peak flux density of ~6 flux units at 611 MHz, and a spectral index of about –1. Measurements were made of sweep rate and pulse arrival time. Assuming a value of 0.1 electrons/cm^3 for the electron density in interstellar space the source could be placed at a distance of 142 pc. Preliminary measurements of average pulse shapes were also made. It is suggested that the pulsar be called AP 2015 + 28. (UK)

49973 SIMULTANEOUS OBSERVATIONS OF A PULSATING RADIO SOURCE OVER A 5000-km BASELINE. Conklin, E. K. (Stanford Univ., Calif.); Howard, H. T.; Craft, H. D.; Comella, J. M. Nature (London), 219: 1238-9(Sept. 21, 1968).

All the recently discovered pulsars show apparently random amplitude variations on several time scales. The shortest is evident in the shape of individual pulse envelopes and is almost certainly intrinsic to the source. There is also an amplitude change from pulse to pulse, which is also thought to be intrinsic, although scintillations near the source may have some effect. A third is a much slower amplitude fluctuation with a time scale of about 1 min at 100 MHz, and up to 1 hr at and above 400 MHz; one explanation for this variation is scintillation, or refraction of the radiation by irregularities in the electron density in interstellar space. In order to examine the spatial correlation of the latter two variations simultaneous observations of the source CP 1919 were made on a common frequency at Stanford and Arecibo on April 22nd 1968. Observations were made between 0900 and 1100 UT, and the projected baseline varied from ~4,850 to 5,500 km. Agreement between results from Stanford and Arecibo was quite good. The high correlations observed in the group envelopes and in the pulse-to-pulse variations indicate that neither fluctuation can be due to a local effect such as Faraday rotation in the ionosphere or interplanetary scintillation; the latter, however, remains a possible explanation for the amplitude variations. (UK)

49974 COSMOGENIC, RADIOGENIC, AND FISSIOGENIC RARE GASES IN IRON METEORITES AND ACHONDRITES. Munk, Miner Nelson. Berkeley, Calif., Univ. of California, 1967. 60p.

Thesis.

Three papers on rare gas anomalies in meteorites are included. Paper I presents the measured abundances of the 21 stable isotopes of neon, argon, krypton, and xenon in the Costilla Peak iron meteorite. A pronounced spallation component was observed in all four of the gases; the neon and argon results agree with previous

iron-meteorite measurements. Calculated production rates for ^{21}Ne and ^{38}Ar give cosmic-ray exposure ages of 560 and 500 m.y., respectively, for a sample depth of 100 g/cm^2. Large variations in the exposure ages based on krypton and xenon might be explained by lack of knowledge about target element abundances. Paper II presents the measured neon, argon, krypton, and xenon compositions in the medium octahedrites Misteca and Carbo. A substantial ^{129}Xe component, and to a lesser extent a ^{131}Xe component, in excess of the trapped and spallation components is observed in Carbo xenon. Otherwise the rare gas compositions can be understood in terms of a cosmic-ray spallation component and a trapped component of atmospheric isotopic composition. Paper III presents the argon, krypton, and xenon analyses of the calcium- and uranium-rich achondrites Angra dos Reis and Nuevo Laredo. By comparing $^{38}Ar/Ca$ ratios with the Stannern calcium-rich achondrite, cosmic-ray exposure ages of 68 and 16 m.y. were obtained for Angra dos Reis and Nuevo Laredo, respectively. Comparison of the xenon results for Angra dos Reis and Nuevo Laredo with the previously reported xenon results for Stannern and Pasamonte suggests that there are two types of fission xenon with significantly different $^{136}Xe/^{132}Xe$ ratios in the calcium-rich achondrites. The ratio of ^{86}Kr from fission to ^{136}Xe from fission in Angra dos Reis is at least a factor of two less than expected from either spontaneous fission of ^{238}U or thermal-neutron-induced fission of ^{235}U. The large amount of fission xenon and the low ratio of fission ^{86}Kr to fission ^{136}Xe both support the hypothesis that a major fraction of the fission xenon is due to the extinct radioactivity ^{244}Pu. (TSS) (Diss. Abstr.)

49975 SELF-ADJOINTNESS FOR LAGRANGIAN SYSTEMS. Kulsrud, Russell M. (Princeton Univ., N. J.). Astrophys. J., 152: 1121-3(June 1968).

A general proof is given for the self-adjointness of operators occurring in the stability of systems which possess a Lagrangian. (auth)

49976 OBSERVATIONS OF SOLAR-FLARE ELECTRONS IN INTERPLANETARY SPACE. Lin, Robert Peichung. Berkeley, Calif., Univ. of California, 1967. 110p.

Thesis.

The observations of >40 keV solar flare electrons by the IMP-III and Explorer 33 satellites were used to study the emission of such electrons from the Sun and their propagation in the interplanetary medium. It is found that there is very little diffusion transverse to the interplanetary magnetic field lines for these electrons in their propagation from the Sun to the Earth, and that the angular extent of the cone of propagation in interplanetary space filled with electrons reflects the angular size of the source at the Sun. This size is typically about 30° solar longitude, but ranges up to 90° for electron events which occur at the time that a type I radio noise storm is covering a similar angular extent of the solar disc. The time behavior of the solar electron fluxes does not fit well to the power law decay predicted by the model of impulsive point source injection into an infinite diffusion medium, but rather exhibits an exponential decay in time as would be expected for the injection of these particles into a bounded diffusing medium. The large, enduring pitch angle anisotropies which are often observed for these electron fluxes indicates that the electrons are essentially escaping beyond 1 A.U., and therefore the diffusing medium must be bounded inside 1 A.U. The diffusion of solar electrons may occur close to the Sun. Comparisons of solar proton and electron onset times for mixed events indicates that the electrons are injected into the interplanetary medium earlier than the protons. Moreover, the proton fluxes on occasion show highly structured spatial variations which are not evident in the simultaneously observed electron fluxes. It is suggested that the solar protons and electrons are produced in different regions of the solar atmosphere; electrons in the upper chromosphere or lower corona and protons in the strong magnetic field regions in the lower chromosphere. The electron events are found to be accompanied by type-III radio emission and impulsive centimeter and x-ray emission, all of which appear to be associated with the optical flash phase which occurs for many flares. The electron, radio and x-ray emission by the flare can all be accounted for by the production of packets of 10^{35} electrons of 10 to 100 keV energies. The characteristics of the electron streams which produce type III radio emission as they escape the Sun are completely consistent with the characteristics of the solar flare electrons observed by the satellites. The solar flare electrons observed by satellites are therefore tentatively identified as the same electrons which generate type III bursts at the Sun. (Diss. Abstr.)

49977 DYNAMICAL MODEL OF A STELLAR SYSTEM. Perek, Lubos (Astronomical Inst., Prague). Bull. Astron. 2: 213-14(1967).

The ellipsoidal velocity distribution leads to physically impossible systems under the usual assumptions. This is probably due to admitting velocities beyond the velocity of escape and contradicting the steady-state assumption. The density decreases too slowly and leads to an infinite total mass. A modified frequency function is therefore proposed and discussed. For reasonable velocity dispersions it can be closely approximated by an ellipsoidal distribution with modified parameters. It admits velocities below the velocity of escape only but its numerical values are almost the same as those of the ellipsoidal law. This slight modification was enough to make the system physically possible. The density is rather sensitive to the numerical values of the parameters. Values typical for Population I lead to a ring with decreasing densities inwards as well as outwards. Population II values show a steep gradient of the density, again in a qualitative agreement with observations. The proposed dynamical model is the simplest case. It is capable of representing actual stellar systems at least in their rough features. (BBB)

49978 GALACTIC ASTRONOMY. Mihalas, Dimitri; Routly, Paul McRae. A Series of Books in Astronomy and Astrophysics. San Francisco, W. H. Freeman and Co., 1968. 269p. $10.00.

This book is intended for use by advanced undergraduate and beginning graduate students qualified in the physical sciences. Apart from elementary astronomical considerations, topics include the distribution of stars in space and velocity, the solar motion, galactic rotation and spiral structure, galactic dynamics, and the dynamics of star clusters. (W.D.M.

49979 ROSSBY AND HAURWITZ WAVES AND SOLAR ATMOSPHERIC DYNAMICS. White, Marvin L. (Cambridge Research Labs., Bedford, Mass.). Icarus, 9: 364-72(Sept. 1968).

The simple empirical formula for the angular velocity of the Sun due to Newton and Nunn is shown to bear remarkable resemblance to the dispersion law for the group velocity of Rossby waves, suggesting the existence of jet streams in the solar atmosphere. It is found that three waves are formed at a given circle of latitude (m = 3), in agreement with Plaskett. The pathline of a tracer element derivable from the elementary Rossby theory, shows poleward drift in the chromosphere. For the photosphere, pathlines are shown to resemble a cycle of the butterfly diagram for the equatorial migration of the active regions. It is also shown that there exists a class of long waves (first discussed by B. Haurwitz) which can give rise to three long-lived continents of solar activity 120° apart which rotates 13.06°/day. This value is in close agreement with that obtained by Marion W. Haurwitz (13.23°/day) for the rigidly rotating system associated with observed high-energy proton (flare) events. The role of "dishpan" experiments in simulating the solar atmosphere is briefly reviewed. (auth)

49980 QUASI-PERIODIC, LOW-FREQUENCY FLUCTUATIONS OF THE RADIO EMISSION OF THE SUN. Yudin, O. I. (Lobachevskii State Univ., Gorky, USSR). Dokl. Akad. Nauk SSSR, 180: 821-3(June 1, 1968). (In Russian).

The characteristic parameters of the solar chromosphere fluctuate around certain mean values. The radio emission of the $\lambda \sim$ 3-cm waves originates in the chromosphere at 5×10^3 to 10^4 km above the photosphere. The effect of the fluctuations of chromospheric parameters on changes of solar radioemission flux has been studied by a quasi-zero registration method by means of the 3.3-cm wave. Statistical studies revealed that when the active region appears on the Sun, the signal level of fluctuations at the exit from the radio meter increases from 0.05 to 1.0% of the mean temperature at the input point of the radio telescope. These events were found to be reproducible in 70 to 80% of the cases. The quasi-zero method was used to separate the effect caused by the origin of the fluctuations resulting from lack of stability of the apparatus, tropospheric circulation, etc. The results pointed to the existence of a quasi-periodic modulation of the solar radio emission at the time of the quiet Sun which increased when activity centers appeared. The frequency of the modulation periods was found to be variable; they coincided with periods of vertical fluctuation of layers of the photosphere and the lower chromosphere, as reported by R. B. Leighton, et al. It was concluded that the quasi-periodic modulation of the radio emission is due to processes taking place in the upper chromosphere. (TTT)

Atomic and Molecular Physics

Refer also to abstracts 49921, 49946, 50067, 50261, 50507, 50565, 50621, and 50622.

49981 (ITEF-535) ANALIZ NEKOTORYKH RASKHOZHDENII V MASS-SPEKTROSKOPICHESKIKH DANNYKH, POLUCHENNYKH ZA PERIOD S 1954 PO 1958 g.g. (An Analysis of

Some Discrepancies in Mass-Spectroscopic Data Obtained During the Period 1954–1958). Arutyunyants, G. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Moscow. Institut Teoreticheskoi i Eksperimental'noi Fiziki). 1967. 24p. (In Russian). Dep.

Some discrepancies are considered between the most precise measurement of light atomic masses (up to ^{40}Ar) by the mass doublet method performed by Brookhaven and Minnesota University groups during the period 1954 to 1958. Some systematical variation in the doublet values vs time of their obtaining is noted. These discrepancies are difficult for explanation by accumulation of the systematic changes in the apparatus. The new explanation of this effect is proposed, assuming that the variations of atomic masses are real and are about some parts in 10^{-7} to 10^{-6} of the mass number per year. Based on the liquid-drop model, formulas were obtained in order to describe these variations. The agreement of the experimental and calculated ones is satisfactory. (auth)

49982 (JINR–P15-3998) MULTIPLE SCATTERING OF 94 TO 294 keV HYDROGEN IONS IN A MUSCOVITE. Govorov, A. M.; Salatskii, V. I.; Telezhnikov, S. A. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Neutron Physics). 1968. 13p. (In Russian). Dep.

Measurements of multiple scattering of protons and ions in muscovite films at energies from 94 to 294 keV were compared with calculations carried out using Molliére theory and the Thomas–Fermi statistical model for describing electrons in atoms. Data obtained showed that experimental results for the angular distribution half widths are about 17% larger for the whole range of energies than those calculated theoretically. (tr-auth)

49983 (N–68-10934) PERFORMANCE OF AN ARC-HEATED SUPERSONIC MOLECULAR BEAM AND ITS APPLICATION TO MOLECULE–MOLECULE COLLISION STUDIES. Kuluve, Neil Marshall (California Univ., Los Angeles. Dept. of Engineering). Apr. 1967. 127p. (NASA-CR-89318). CFSTI.

Thesis.

The molecular beam density, energy, and velocity of the arc-heated, supersonic, argon molecular beam system were studied experimentally. In the tests, a flow-through ionization detector was used to monitor the beam density, with a single-disk chopper or a two-disk velocity filter used to modulate the beam. A photocell apparatus, focused on either of the velocity filter disks or on the beam chopper disk, provided the triggering signal for beam detection. The parameters varied during the experiments included the plasma head power input, plasma unit electrode configurations, stagnation chamber pressure, argon mass flow, distance from the nozzle to the skimmer, nozzle diameter, skimmer diameter, source chamber pressure, and collimating chamber pressure. Measured beam energies ranged as high as 2.7 ev; argon–argon integral collision cross sections were measured using angular resolutions as small as 2.2′. It was concluded that the applicability of the arc-heated supersonic molecular beam to collision cross section measurement in the 1 to 10 ev energy range was demonstrated. (STAR)

49984 (N–68-20295) ELECTRON BEAM, CRYSTALLIZATION OF SILICON, GERMANIUM, AND CADMIUM SULFIDE. Evans, John C. Jr. (National Aeronautics and Space Administration, Cleveland, Ohio. Lewis Research Center). Apr. 1968. 24p. (NASA-TN-D-4522). CFSTI.

Amorphous semiconductor films were electron-beam irradiated, and the effects were observed in the electron microscope. This study shows that oriented polycrystalline films of silicon, germanium, and cadmium sulfide may be made by electron bombardment of their amorphous films deposited on glass and plastic substrates. This transition was shown to occur without deleterious effects upon the substrates. The film bombardment was conducted both in the electron microscope and in a separate vacuum crystallizer capable of electron-beam raster scanning. Electron micrographs and electron diffraction patterns were used to record the results of the film treatments. Both silicon and germanium films underwent amorphous-to-crystalline changes at substrate temperatures well below the melting points of the semiconductors. Nucleation and crystal growth by coalescence were observed. The compound semiconductor, cadmium sulfide, crystallized by passing through a quasi-liquid state without subliming in the vacuum environment. The thickness of the untreated films was such as to allow transmission electron microscopic studies. (auth) (STAR)

49985 (NP–17621) CHARGE EXCHANGE COLLISIONS INVOLVING MULTI-ELECTRON ATOMS (Li AND Na). Lodge, J. G.; May, R. M. (Sydney Univ. (Australia). School of Physics). July 1968. 27p. (TR–21). Dep.

The Brinkman–Kramers approximation and a simple effective-Z wave function together with a multiplicative correction factor are used to estimate charge-exchange cross sections for protons on lithium and sodium, and the results are compared with experiment. The lithium case is then extended, first to include the inner electrons and then to a calculation using a more satisfactory wave function. (auth)

49986 (NRC-TT–1316) NEGATIVE IONS FROM ALKALI HALIDES AND ELECTRON AFFINITIES OF ALKALI METALS AND ALKALI HALIDES. Ebinghaus, H. Translated by D. A. Sinclair for National Research Council of Canada, Ottawa, from Z. Naturforsch., 19a: 727-32(1964). 10p. Dep. CAN.

The formation of negative ions from alkali metal halide vapors by electron resonance capture was investigated by mass spectrometry. The ions found, of the form M^-, X^-, MX^-, and M_2X^- (M = Li, Na, K, Rb, Cs; X = F, Cl, Br, I) could be said, on the basis of the energetics and relative intensities, to originate from monomeric and dimeric molecules. From the measured appearance potentials and known dissociation energies, lower limits were established for the electron affinities of the alkali metals. These are in the vicinity of 0.5 eV. For some alkali metal halides, they are about 1.2 eV. In the case of the alkali metals, presumably these values are the actual electron affinities. Following the reports from various quarters on the formation of positive ions from alkali halides by electron impact, it appeared interesting also to investigate the formation of negative ions from alkali halide molecules, especially as there was a possibility of determining the electron affinities of the alkali metals, for which there had hitherto been scarcely any experimental data, although many theoretical values were available. The experiments with positive ions show that dimeric and trimeric molecules, as well as monomeric ones, are present in alkali halide vapours, so that negative ions might also be expected from these polymers. The measurements were restricted to resonance captures, i.e., to electron energies of less than 10 eV. (auth)

49987 (ORNL-TM–2261) ELECTRONIC PROPERTIES OF LIQUID WATER IN THE VACUUM ULTRAVIOLET REGION. Painter, Linda R.; Birkhoff, R. D.; Arakawa, E. T. (Oak Ridge National Lab., Tenn.). Sept. 1968. Contract W-7405-eng-26. 113p. Dep. CFSTI.

Thesis. Submitted to Univ. of Tennessee, Knoxville.

In this study, n and k, the real and imaginary parts of the complex index of refraction, have been determined for water in the spectral region 1050 to 3000 Å. In order to determine the optical properties of water in the vacuum ultraviolet, two general methods were used. In the first the reflectance of water in equilibrium with its vapor at 1°C was measured in the spectral region 1050 to 3000 Å for three angles of incidence. Light from a Seya–Namioka monochromator was reflected from a gold mirror onto either the water surface or a gold reference surface at the various angles and reflected specularly onto a coronene-coated photomultiplier. The optical constants were then obtained from a solution of Fresnel's equations. This method gave reliable values of n, but the reflectances measured in this way were not accurate enough to give good values of k. The second method involved placing water against the plane surface of a transparent semicylinder which formed one side of a sealed cell. Light is incident normally on the curved surface, reflects from the water–semicylinder interface and exits, again normally. A quartz semicylinder was used down to 1680 Å where it becomes opaque and a CaF_2 semicylinder from 1680 down to 1250 Å. The reflectance was measured as a function of angle of incidence for angles between 13 and 87°. From 1250 to 1720 Å, the optical constants n and k were determined from a least squares fit of the measured reflectances to Fresnel's equations. Above 1720 Å, the absorption of water becomes weak and a critical angle may be measured from which the index of refraction n was determined. Values of k were determined from the shape of the reflectance curve just above the critical angle, since the reflectance in this region is very sensitive to k. This method of determining k was applicable for k values between about 0.02 and 0.0005. The optical constants as determined using a semicylinder are relative to the index of refraction of the semicylinder and must be multiplied by the semicylinder index to be compared with vacuum-water constants. Real and imaginary parts of the complex index of refraction, $\tilde{n} = n + ik$, and the complex dielectric constant, $\epsilon = (\tilde{n})^2 = \epsilon_1 + i\epsilon_2$, deduced from the data and Fresnel's equations, suggest an exciton transition at 8.3 eV, an interband transition at 9.6 eV, and a band gap of 9 eV. (auth)

49988 (SLAC–86) TRANSMISSION SECONDARY EMISSION FROM THIN FILMS OF ALKALI HALIDES. Llacer, Jorge (Stanford Linear Accelerator Center, Calif.). Aug. 1968. Contract AT(04-3)-515. 186p. Dep. CFSTI.

The phenomenon of secondary emission from alkali metal halides has been studied theoretically and experimentally in sub-

stantial detail. Transmission type measurements have been chosen, rather than reflection, because the former method gives one more parameter (thickness) for comparisons between experiments and theory. The energy loss suffered by primary electrons is obtained from published experimental results of electron scattering by thin foils. The escape of low-energy electrons (.25 to 7.5 eV) is studied in detail using time-dependent perturbation theory. The resulting transport problem is solved with the exact scattering probability distribution by a Monte Carlo method. It is shown that for low-energy electrons generated isotropically inside a solid, an exponential probability of escape exists. Escape parameters and energy losses are computed for CsI, KCl, NaF, and LiF, representing alkali metal halides from the highest to lowest Z. The experimental yield of films of those four materials, for thicknesses of 125 to 1000Å, has been measured by a pulsed method. The energy distribution of emitted electrons for the same materials has also been measured, making certain that the films remained uncharged. A Kelvin probe was used to establish that fact and also to determine a true zero of contact potential difference between collector and emitter. A mathematical model of secondary emission based on the detailed theoretical results is proposed and found to agree well with the experiments. Approximate internal excitation functions and composite escape functions for secondaries are computed. The results show that perturbation theory gives good quantitative values of escape parameters and that secondary emission from alkali halides is mainly determined by the energy losses suffered by primaries and by the electron–phonon interaction of the internal secondaries. A high atomic number is favorable for both mechanisms and the difference between the yields of extreme materials like CsI and LiF is quite understandable. (auth)

49989 FADDEEV EQUATIONS FOR ATOMIC PROBLEMS AND SOLUTIONS FOR THE (e,H) SYSTEM. Ball, James S. (Univ. of California, Los Angeles); Chen, Joseph C. Y.; Wong, David Y. Phys. Rev., 173: 202-13(Sept. 5, 1968).

Solutions of the Faddeev equations for Coulomb potentials are investigated. A method which is of practical use for solving the Faddeev equations below the three-particle breakup threshold is developed. As an example, the method is applied to the (e, H) system in which the H^- bound state and the lowest members of the resonances in both the singlet and the triplet J = 0 series are calculated. The results are in good agreement with the experimental measurements and previous calculations which used conventional methods. (auth)

49990 POSITRONIUM AND MUONIUM. Kinell, Per-Olof (Forskningsradens Lab., Studsvik, Sweden). Sv. Kem. Tidskr., 78: 644-63(1966). (In Swedish).

A review is presented concerning the formation of the element positronium from a positron and an electron, and the element muonium from a positive muon and an electron. The physical properties of these systems are discussed and the role of the 2 elements in some chemical reactions is elucidated. Experimental techniques used for studying such short-lived systems are presented. (BBB)

49991 DRIFT VELOCITIES OF HELIUM MOLECULAR IONS. Orient, O. J. (Polytechnical Univ., Budapest). Phys. Lett., 27A: 542-3(Sept. 9, 1968).

The drift velocities of two types of helium molecular ions have been measured in helium gas as a function of E/p_0. Up to E/p_0 = 10 V/cm torr the drift velocities increase linearly. A transition follows after this value, and from 30 E/p_0 on the drift velocities of the two kinds of molecular ions go increasing as the square root of the field strength, as in the case of atomic ions. (auth)

49992 ANGULAR CORRELATION OF POSITRON ANNIHILATION RADIATION FROM ZINC SINGLE CRYSTALS AT 250°C. Kusmiss, J. H.; Swanson, J. W. (Western Michigan Univ., Kalamazoo). Phys. Lett., 27A: 517-19(Sept. 9, 1968).

The angular correlation of positron annihilation radiation from oriented single crystals of zinc has been measured at 25 and 250°C. There are no significant differences between the single-crystal results and the polycrystalline results. (auth)

49993 POSITRON ANNIHILATION WITH HALOGENIDE IONS. Gambarini, G.; Zappa, L. (Istituto di Fisica del Politecnico, Milan). Phys. Lett., 27A: 498-9(Sept. 9, 1968).

The annihilation of positrons in substances of unsymmetrical valence type such as fluorite was investigated. It was found that the lifetimes are nearly equal to those observed in alkali halides having the same anion. (auth)

49994 POLARIZATION TRANSFER BETWEEN ORIENTED METASTABLE HELIUM ATOMS AND NEON ATOMS. Schearer, L. D. (Texas Instruments Inc., Dallas). Phys. Lett., 27A: 544-5(Sept. 9, 1968).

Spin exchange accompanying energy-transfer collisions between optically pumped metastable helium atoms and neon atoms has been observed. The magnetic resonance of the helium metastable atoms is observed by monitoring changes in the polarization of the radiation emitted by the neon at a variety of neon wavelengths. (auth)

49995 PROTON EXCITATION OF HELIUM IN THE DISTORTION APPROXIMATION. Davison, W. D. (Queen's Univ., Belfast). Phys. Lett., 27A: 570-1(Sept. 9, 1968).

The distortion approximation is applied to the excitation of ground state helium to the 3^1D and 4^1D states by proton impact. Comparison with experiment indicates that coupling through intermediate states is more important in ^1D excitation than in ^1P excitation. (auth)

49996 CHEMICAL EFFECTS ON THE ISOMER SHIFT IN ^{151}Eu. Gerth, G.; Kienle, P.; Luchner, K. (Technische Hochschule, Munich). Phys. Lett., 27A: 557-8(Sept. 9, 1968).

Chemical effects on the isomer shift in ^{151}Eu were investigated systematically and calibrated to derive the change of the mean square charge radius $\delta\langle r^2\rangle$ due to the 21.7-keV transition. (auth)

49997 INFRARED LASER EMISSIONS IN THULIUM AND YTTERBIUM VAPORS. Cahuzac, Ph. (CNRS, Orsay, France). Phys. Lett., 27A: 473-4(Sept. 9, 1968). (In French).

Twenty infrared laser lines have been observed with pulsed discharges (2 μsec, 200 A) in thulium and ytterbium vapors. (auth)

49998 INTERPRETATION OF RED SATELLITE BANDS IN ATOMIC SPECTRA. Farr, Judith M.; Hindmarsh, W. R. (Univ. of Newcastle upon Tyne, Eng.). Phys. Lett., 27A: 512-13(Sept. 9, 1968).

The quasi-static theory of pressure broadening is applied to the case of a Lennard-Jones interaction between the radiating atom and its perturbers, and is shown to predict the existence of red satellite bands. (auth)

49999 NONLINEARITY AND HYSTERESIS EFFECTS IN THE VARIATION WITH TEMPERATURE OF THE ISOMER SHIFT IN Eu_2O_3. Deeney, F. A.; Delaney, J. A.; Ruddy, V. P. (University Coll., Cork, Ireland). Phys. Lett., 27A: 571-2(Sept. 9, 1968).

An anomalous variation with temperature of the isomer shift in Eu_2O_3 has been found. This is interpreted in terms of the passage of the oxide through order–disorder phases or pseudophases. The hypothesis is supported by the observation of hysteresis effects. (auth)

50000 ASSESSMENT OF THE QUALITIES OF SOME ELECTRONIC WAVE FUNCTIONS BY A MODIFIED LOCAL-ENERGY METHOD. Rourke, T. A. (Univ. of Manitoba, Winnipeg); Stewart E. T. Can. J. Phys., 46: 1603-12(July 15, 1968).

The validity and desirability of using different weighting factors with the modified local-energy method which was developed previously are indicated. The possible advantages of this method over the variation method are discussed and a search is made among the more common types of wave function for those which are of sufficiently high quality for use with this modified local-energy method. It is shown that the more common wave functions are unlikely to reach this standard except when electron–electron correlation effects are very low. A regression curve for the accuracy of energies by the present method and the accuracy by the variation method is given. It shows that the results from the variation method are always likely to be more accurate than those from the modified local-energy method when the same wave functions are used. Since one advantage of a local-energy method is the ease with which the type of wave function can be changed, a more systematic search for suitable wave functions by optimizing the analytical expression as well as variable parameters appears worthwhile. (auth)

50001 EFFECTIVE NUMBER OF ANNIHILATION ELECTRONS PER ATOM FOR FREE POSITRONS IN CONDENSED MATTER. Cova, S.; Zappa, L. (CNR, Milan). J. Phys., B (London), 1: 795-801(Sept. 1968).

The lifetime of free positrons being annihilated in various condensed substances displaying molecular or covalent bonds was measured. It was found that the structural properties of the molecules and of the materials have only a negligible effect on the free-positron decay rate. Each atom contributes to the annihilation with an effective number ξ of electrons irrespective of the bond. This effective number is found to depend on the atomic size and on the electronic configuration of the atomic external shell. In particular, the ratio of the number ξ to the number ν of electrons in the external shell is found to increase with increasing atomic size. A criterion was also obtained for the identification of the free-positron component in the time annihilation spectra of polymeric compounds which display a complex spectrum. (auth) (UK)

50002 SOME FEATURES OF THE SECONDARY, SLOW-ION INDUCED EMISSION BY W–Mo ALLOYS. Arifov, A.; Gruich, D. D.; Khamidova, Kh. M. (Inst. of Electronics, Tashkent). Dokl. Akad. Nauk SSSR, 180: 1075-7(June 11, 1968). (In Russian).

The energy spectrum of secondary ions emitted by alloys in the low-energy range was investigated in order to clarify the effect of the atomic bond on the crystal lattice. The authors' previously described method was used for the study, in which a high-resolution, 127° cylindrical condenser served as analyzer. A 10^{-8}-A beam of K^+ ions was directed onto the target consisting of a 50–50 W–Mo alloy; similar experiments were carried out with pure metals. The primary beam was directed at an angle of $\alpha = 55°$; the secondary ions were analyzed under a scattering angle of $\theta = 71°$ in a vacuum of 5×10^{-8} torr. The oscillogram obtained by the bombardment of the alloy heated to 1350°K exhibited 3 peaks indicating pair collisions. A decrease of the initial energy resulted in the gradual disappearance of the peak of elastically scattered ions from W; this is probably due to the formation of a layer of Mo atoms on the alloy and to the fact that the lower energy scattering takes place at lower depths. This fact may be used to determine the thickness of the layer and the size of the potential barrier at the surface of the target. Increase of the temperature to 1700°K also resulted in the gradual decrease of the elastically scattered ions by W, indicating that the thickness of the deposited Mo film was also increased. (TTT)

50003 SCATTERING OF LOW-ENERGY ELECTRONS FROM A COPPER(III) SURFACE. Marklund, I.; Andersson, S.; Martinsson, J. (Chalmers Univ. of Tech., Gothenburg, Sweden). Ark. Fys., 37: 127-39(1968).

Elastic and inelastic scattering of electrons from a clean and an oxygen-covered Cu(111) surface were investigated with a modified LEED-apparatus using primary beam energies of 5 to 400 eV. Characteristic energy losses of 4.3, 7.6, 10.0, 19.0, 27.2, and 74 eV are observed and interpreted in terms of interband transitions and plasma oscillations. Two overlapping peaks due to Auger-ejected electrons from the valence band are observed at 55.3 and 57.7 eV. These values agree fairly well with those calculated. Adsorption of oxygen on the copper surface at room temperature produces new diffraction beams and gives an increased background of elastically scattered electrons in the diffraction pattern. In the energy spectrum the loss peaks are found to be damped with oxygen exposure in a way that permits interpretation of their origin. (auth) (Sweden)

50004 ISOTOPE SHIFT IN THE RESONANCE LINES OF ^{131}Cs. Huehnermann, Harry; Wagner, Hermann (Univ., Marburg, Ger.). Z. Phys., 216: 28-32(1968).

Reactor-produced ^{131}Cs ($T_{½}$ = 9.7 d) was used to investigate the isotope shift against the stable nuclide ^{133}Cs in the resonance lines of the Cs I spectrum. Special techniques to prepare the hollow cathode and a completely digitalized method of measuring and evaluation of the hyperfine structure made it possible to investigate short-lived isotopes with high accuracy. The following results were obtained: $\Delta\nu_{15}(133-131; 6p\ ^2P_{½} - 6s\ ^2S_{½}) = -0{,}39\ (9)$ mK and $\Delta\nu_{15}(133-131; 6p\ ^2P_{½} - 6s\ ^2S_{½}) = -0{,}28\ (20)$ mK. (auth)

50005 ABUNDANCE OF EXCITED IONS IN AN NO^+ ION BEAM. Mathis, R. F.; Turner, B. R.; Rutherford, J. A. (Gulf General Atomic Inc., San Diego, Calif.). J. Chem. Phys., 49: 2051-6 (Sept. 1, 1968).

A study of a beam of NO^+ ions has been undertaken to determine the relative abundances of excited-state ions and ground-state ions. The experimental procedure involved the attenuation of the ion beam in a gas-filled reaction chamber where different states of the ion were attenuated at different rates. The ions were produced from NO by impact of electrons with energies of 25, 50, and 100 eV. The abundances were determined ~20 μsec after the ions were formed, so that only ions in long-lived states remained in the beam. Several gases, H_2, N_2, O_2, H_2O, and Ar, were employed in the attenuation chamber to assess the importance of de-excitation processes and to reduce the possibility of identical-loss cross sections for excited and ground states. It was found that high pressures in the ion source, as well as the electron energy, could influence the abundance of excited-state ions. A typical result was that, using 50-eV electrons and low source pressures, 42% of the ions in the beam were excited. (auth)

50006 SCATTERING AND PICK-OFF QUENCHING OF ORTHOPOSITRONIUM IN HELIUM. Fraser, P. A. (Univ. of Western Ontario, London). J. Phys., B (London), 1: 1006-9 (Sept. 1968).

An error in some earlier reported work on orthopositronium collisions with helium and on the pick-off quenching of orthopositronium by helium is pointed out, and corrected results are presented. The scattering length is decreased by 13% to 1.88 α_0, and the theoretical pick-off quenching rate is doubled. The revised quenching rate is still much smaller than experimental observations. (auth) (UK)

50007 ELECTRON-IMPACT IONIZATION CROSS SECTION IN CESIUM. Nygaard, Kaare J. (Sperry Rand Research Center, Sudbury, Mass.). J. Chem. Phys., 49: 1995-2002(Sept. 1, 1968).

The total ionization due to the passage of an electron beam in cesium vapor has been measured with a Tate and Smith type apparatus. The retarding potential difference method was used in the electron gun to obtain energy resolution better than 0.1 eV. The density of Cs atoms was determined from the Taylor and Langmuir formula and also measured with a surface-ionization detector. The two methods gave the same density to within ±3% when the apparatus was in thermodynamic equilibrium with the Cs reservoir. The cross section for production of Cs^+ has been determined from threshold to 100 eV. For energies above 28 eV, the results agree closely with those of McFarland and Kinney. At threshold the slope of the cross-section-vs-energy curve was measured to be 2.7 $Å^2$/eV. (auth)

50008 DISTORTED-WAVE THEORY FOR COLLISIONS OF AN ATOM AND A DIATOMIC MOLECULE. Miller, William H. (Univ., Freiburg i. B.). J. Chem. Phys., 49: 2373-81 (Sept. 1, 1968).

The general collision of an atom and a diatomic molecule (interacting through a single potential surface) is treated in the distorted-wave Born approximation (DWBA). The scattering amplitude in the helicity representation is given by equations and is seen to be an intuitive generalization of the usual partial-wave expansion for potential scattering. This general result contains only three-dimensional integrals, which must be evaluated, in contrast to the six-dimensional space of the system in its center of mass. Both distorted wave functions suggested by Karplus and Tang (free molecular functions and adiabatic molecular functions) are treated and lead to the same form for the scattering amplitude. Several semiclassical approximations are presented with regard to the sum over partial waves. These lead to physically interesting results, and a numerical example is presented to indicate how accurate they may be expected to be. (auth)

50009 DETERMINATION OF EXCITATION CROSS SECTIONS OF CERTAIN O_2^+ BANDS BY A INTERSECTING BEAM METHOD. Korol, V. I.; Kishko, S. M.; Skubenich, V. V. (Uzhgorod State Univ., USSR). Ukr. Fiz. Zh., 13: 1225-6(July 1968). (In Russian).

Cross section magnitudes of certain O_2^+ band excitation by slow electrons were obtained previously, using discharge tubes filled with the gas. In this study, a discharge tube was used in which the gas as a molecular beam was excited by an intersecting electron beam. The electron beam control and photoelectric recording of the emission were carried out with UM-2 and ZMR-3 monochromators. Absolute cross section magnitudes of the O_2^+ excitation of the first ($b + \Sigma_g^- \rightarrow a^4\Pi u$) and second ($A^2\Pi u \rightarrow X^2\Pi_g$) bands were measured by comparing the band intensities with the spectra of corresponding standards. The absolute curves of the excitation functions of the bands of the first and second negative systems O_2^+ are given and cross sections for maximum O_2^+ band emission intensities are tabulated. (R.V.J.)

50010 ION–MOLECULE REACTION STUDIES FROM 300° TO 600°K IN A TEMPERATURE-CONTROLLED FLOWING AFTERGLOW SYSTEM. Dunkin, D. B.; Fehsenfeld, F. C.; Schmeltekopf, A. L.; Ferguson, E. E. (Environmental Science Services Administration, Boulder, Colo.). J. Chem. Phys., 49: 1365-71(Aug. 1, 1967).

The flowing afterglow technique for ion-neutral reaction rate constant studies has been modified to cover a range of gas temperature from 82° to 600°K. The experimental apparatus is described and rate constants for six reactions between 300° and 600°K are reported. The reaction of He^+ with N_2 is found to have a rate constant 1.2×10^{-9} cm³/sec, independent of temperature in this range. The reaction of O^+ with CO_2 has a rate constant 1.1×10^{-9} cm³/sec at 300°K, decreasing slightly to 8×10^{-10} cm³/sec at 600°K. The reaction of N^+ with O_2 appears to have a rate constant 6×10^{-10} cm³/sec throughout this temperature range. The rate constant for charge transfer of N_2^+ with O_2 is measured to be 4.7×10^{-11} cm³/sec at 300°K, decreasing to about 2×10^{-11} cm³/sec at 500°K. The rate constant for the reaction of O^+ with O_2 decreases from 2 to 1.3×10^{-11} cm³/sec, and the rate constant for $O^+ + N_2$ decreases from 1.2×10^{-12} cm³/sec to about 6×10^{-13} cm³/sec between 300° and 600°K. (auth)

50011 SCATTERING OF β RADIATION ON A THICK FOIL: PRODUCTION OF TRANSVERSE POLARIZATION. Braicovich, L.; De Michelis, B.; Fasana, A. (Istituto di Fisica del Politecnico, Milan. Consiglio Nazionale delle Ricerche, Rome). Phys. Rev., 174: 460-2(Oct. 10, 1968).

The ^{90}Sr + ^{90}Y β rays are scattered by a thick lead foil so that

the longitudinal polarization of the electrons is partially converted into a transverse one. This transverse polarization is measured with a Mott polarimeter, as a function of the total scattering angle between 30° and 140° and of the energy of the scattered electrons between 0.25 and 1.46 MeV. In this energy interval, the transverse polarization varies from about 16 to 28% of the longitudinal polarization of the incident beam. These results clarify the interpretation of the large longitudinal depolarizations observed in the backscattering of β rays by lead and reported in a preceding paper; in this connection it is possible to conclude that the disordering of the beam with a shrinkage of the polarization vector is the most important process. In the Appendix, some remarks on the dependence of the transverse polarization production on the scatterer atomic number are given. (auth)

50012 SOME TOTAL ELECTRON-CAPTURE CROSS SECTIONS FOR H_2^+ AND H_3^+ IMPACT ON Ne, AND H_3^+ ON Ar. Hughes, R. H.; Kay, D. B.; Stigers, C. A.; Stokes, E. D. (Univ. of Arkansas, Fayetteville). J. Chem. Phys., 49: 2459-60 (Sept. 1, 1968).

Total beam-attenuation cross sections Q_T were measured for H_2^+ and H_3^+ ion beams passing through collision chambers containing Ar and Ne. Chamber lengths of 5.5 and 12.5 cm were used. Approximate agreement of Q_T values obtained with the two chambers indicated that the effect of large-angle scattering was small, and it was concluded that Q_T for the short chamber can be taken as a measure of the electron-capture cross section. Results are plotted for H_2^+ on Ne and H_3^+ on Ne and Ar. (A.G.W.)

50013 PROTON EXCITATION OF THE 1300-A CONTINUUM IN ARGON. Hurst, G. S. (Univ. of Kentucky, Lexington); Bortner, T. E.; Strickler, T. D. J. Chem. Phys., 49: 2460-1 (Sept. 1, 1968).

Protons from a 6-MeV Van de Graaff were used to excite Ar under conditions that allowed good estimates of energy losses as a function of gas pressure. The relative light intensity in the region of 1300 Å was found to be a well-behaved function of gas pressure from 100 to 1200 torr provided that the Ar was extremely pure. It is suggested that the 1300-Å continuum produced in Ar by proton excitation is due mainly to the collision of Ar atoms excited to one of their resonance levels ($^1P_1$) with Ar atoms in their ground states. (A.G.W.)

50014 PERTURBATION THEORY FOR EXCHANGE INTERACTIONS BETWEEN ATOMS OR MOLECULES. II. Ritchie, A. B. (Univ. of Virginia, Charlottesville). J. Chem. Phys., 49: 2167-70 (Sept. 1, 1968).

A perturbation theory is developed for interacting atoms or molecules in the region in which exchange becomes important. Use of a set of linear operators that project out the components of the antisymmetrized state vector permits the derivation of a set of exact integral equations, each for a single component of the vector, which can be solved by ordinary perturbation–theoretic techniques. In this way, exchange can be treated exactly, without the necessity of obtaining an orthogonalized basis. (auth)

50015 USE OF GREEN FUNCTIONS IN ATOMIC AND MOLECULAR CALCULATIONS. II. THE GREEN FUNCTION OF THE HELIUM ATOM. Hameka, Hendrik F. (Univ. of Pennsylvania, Philadelphia). J. Chem. Phys., 49: 2002-8 (Sept. 1, 1968).

An analytical expression is derived for the Green function of the helium atom, that is to say for the helium atom where the electron repulsion term (e^2/r_{12}) has been neglected. This Green function may be used as a basis for a numerical iterative procedure to derive the exact eigenfunctions of the helium atom. (auth)

50016 USE OF GREEN FUNCTIONS IN ATOMIC AND MOLECULAR CALCULATIONS. III. SECOND-ORDER PERTURBATION OF THE HYDROGEN MOLECULAR ION. Pan, Yen-chi; Hameka, Hendrik F. (Univ. of Pennsylvania, Philadelphia). J. Chem. Phys., 49: 2009-18 (Sept. 1, 1968).

Analytical expressions were derived for the second-order perturbation energy of a hydrogen atom perturbed by a point charge λ at a distance R. Here the charge λ is taken as the perturbation parameter. The calculations make use of Green-function techniques and of the hydrogen-atom Green function derived in a previous publication. (auth)

50017 USE OF GREEN FUNCTIONS IN ATOMIC AND MOLECULAR CALCULATIONS. IV. THE GREEN FUNCTION OF THE LITHIUM ATOM AND OF THE OTHER ATOMS. Hameka, Hendrik F. (Univ. of Pennsylvania, Philadelphia). J. Chem. Phys., 49: 2019-25 (Sept. 1, 1968).

An analytical expression is derived for the Green function of the lithium atom, that is to say for the lithium atom where the electron repulsion terms (e^2/r_{ij}) have been neglected. It is shown that the derivation is easily generalized to all other atoms and ions. (auth)

50018 MODIFIED PERTURBATION THEORY FOR ATOMS AND MOLECULES BASED ON A HARTREE–FOCK φ_0. Silverstone, Harris J.; Yin, Moon-Iung (Johns Hopkins Univ., Baltimore). J. Chem. Phys., 49: 2026-30 (Sept. 1, 1968).

The improvement of Hartree–Fock wave functions by perturbation theory is hampered by slow convergence with the usual choice of $H_0 = \sum_{i=1}^{N} F(i)$, where F denotes the one-electron Hartree–Fock Hamiltonian. The slow convergence is usually attributed to the unphysical nature of the excited states of F, which do not describe electrons moving in the field of the nuclei shielded by N-1 electrons. It is shown how to redefine F so that the zeroth-order wave function still remains the Hartree–Fock wave function but so that the excited states of F correspond to an electron moving in the field of the nuclei screened by N-1 electrons. The redefined F thus results in a more appropriate H_0. Calculations of some second-order polarization and semi-internal correlation energies in first-row atoms are given to illustrate the use of the redefined F. (auth)

50019 AB INITIO SPECTROSCOPIC INTEGRALS FOR Th I. Wilson, M. (Argonne National Lab., Ill.). J. Opt. Soc. Amer., 58: 1404-5 (Oct. 1968).

Hartree–Fock solutions have been obtained for eight configurations of Th I. Slater integrals, configuration–interaction integrals, and dipole integrals of spectroscopic interest are presented. (auth)

50020 Z-DEPENDENCE OF THE STOPPING POWER AT LOW ENERGIES. Turos, A. (Inst. of Nuclear Research, Warsaw). Nucl. Instrum. Methods, 64: 208-10 (Sept. 15, 1968).

A method is described for determining the stopping power of an arbitrary medium in dependence on its atomic number Z for H and He ions of energies 0.5–8 MeV/amu. (auth)

50021 STUDY OF SOME OF THE ATOMIC LEVELS OF MERCURY BY MEANS OF THE OPTICAL METHODS OF HERTZIAN SPECTROSCOPY. Popescu, I. M. (Inst. of Atomic Physics, Bucharest). Stud. Cercet. Fiz., 20: No. 1, 25-90 (1968). (In Rumanian).

Extension of the optical detection method of magnetic resonance to the study of the ground states of atomic or molecular systems, making use of optical pumping, yielded valuable additional information about resonances. Later developments allowed to apply the optical pumping to atoms with a diamagnetic ground state, making it possible to observe effects not detectable by optical spectroscopy. Levels of mercury have been also studied by magnetic resonance, including the 6^3P_1 level of Hg I, the Stark effect of the even mercury isotopes, determination of collision cross sections, etc. The optical pumping technique was also used to study the magnetic resonance of ^{199}Hg and ^{201}Hg, determining the nuclear magnetic moments. The double resonance method was used to calculate the 7^3S_1 level of Hg I. For the study of the magnetic levels of ^{201}Hg, the Hg I λ1850 Å line was used. (Doctoral thesis, 144 references). (TTT)

50022 EXPERIMENTAL TRANSITION PROBABILITIES FOR TRIPLET–SINGLET TRANSITIONS IN HELIUMLIKE HEAVY IONS. Sellin, I. A. (Oak Ridge National Lab., Tenn.); Donnally, Bailey L.; Fan, C. Y. Phys. Rev. Lett., 21: 717-19 (Sept. 9, 1968).

The transition probability of the $1^1S_0 - 2^3P_1$ transition was measured in the helium-like ions O^{6+} and N^{5+}. The results were $(5.2 \pm 1) \times 10^8$ sec^{-1} and $(1.7 \pm 0.3) \times 10^9$ sec^{-1}, respectively. They agree well with very recent calculations. (auth)

50023 H(2p) EXCITATION RESONANCES IN (e-H) SYSTEM NEAR THRESHOLD. Williams, J. F.; McGowan, J. William (Gulf General Atomic Inc., San Diego, Calif.). Phys. Rev. Lett., 21: 719-21 (Sept. 9, 1968).

High-resolution electron-impact measurements reveal that just above the threshold for excitation of the 2p level of atomic hydrogen there is a complicated resonance structure, part of which had not previously been predicted or observed. (auth)

50024 POST-THRESHOLD BEHAVIOR OF THE CROSS SECTIONS FOR THE 1s–2p EXCITATION BY ELECTRON IMPACT. Marriott, R.; Rotenberg, Manuel (Univ. of California, San Diego, La Jolla). Phys. Rev. Lett., 21: 722-3 (Sept. 9, 1968).

Detailed numerical reexamination of the 1s–2p cross section for the excitation of hydrogen by electron impact shows structure at 10.4 and 10.6 eV which has not been previously reported. The calculations tend to confirm the recent data of Williams and McGowan. It is suggested that the structure is the result of interference between background potential scattering and the resonance just above n = 2 threshold. (auth)

50025 ANGULAR DISTRIBUTION OF THE OUTGOING ELECTRONS IN ELECTRONIC IONIZATION. Glassgold, A. E.; Ialongo, G. (New York Univ., N. Y.). Phys. Rev., 175: 151-9 (Nov. 5, 1968).

The information which can be obtained from measurements on

both the outgoing particles in single ionization is discussed for the case of high-energy electrons incident on neutral one- and two-electron atoms. The Born approximation is used to analyze a particular experiment suggested by studies of the nuclear (p,2p) reaction. It is concluded that the momentum distribution for the single-electron orbitals of atomic systems can be determined by experiments of this type. The effects of identity and correlations are investigated, especially for the case of target helium atoms. (auth)

50026 POLARIZATION OF LIGHT FROM COLLISION OF A PROTON BEAM WITH HELIUM ATOMS. Krause, Daniel Jr.; Soltysik, Edward A. (Univ. of Massachusetts, Amherst). Phys. Rev., 175: 142-51(Nov. 5, 1968).

The relative cross sections and the polarization of the light resulting from the excitation of helium by a proton beam for several transitions were measured. The analysis indicates that there is a small violation of the $\Delta S = 0$ spin rule for the excitation of the 3 ^{3}D and 3 ^{3}S states of helium by protons. (auth) (TSS)

50027 ANALYSIS OF THE HARRIS VARIATIONAL METHOD IN SCATTERING THEORY. Nesbet, R. K. (IBM Research Lab., San Jose, Calif.). Phys. Rev., 175: 134-42(Nov. 5, 1968).

The variational method recently proposed by Harris for calculation of scattering phase shifts is analyzed in the context of the standard methods of Kohn and Hulthén. The Hulthén method is shown to give a result identical to the Harris method at the energy eigenvalues characteristic of the latter. The Kohn method and its analog for the cotangent of the phase shift, the second Hulthén or Rubinow method, lead to somewhat different limiting values of the phase shift at a Harris eigenvalue. The Harris method is an application to nonresonant situations of a formalism appropriate to scattering resonances. A new method is proposed to deal with stationary states, true resonances, and nonresonant scattering within a common formalism, which defines effective width and shift functions for all values of the energy in terms of a Breit–Wigner formula. The proposed resonance formalism is expressed in forms equivalent to the Rubinow method and to the Hulthén method. A method of smoothing out irregular behavior of computed Hulthén phase shifts, due to branch points at Harris eigenvalues, is proposed. The Kohn and Rubinow methods are shown to give smooth results near Harris eigenvalues. Spurious fluctuations encountered in computations by the Kohn method are shown to be due to poles not present in the Hulthén method. Similar poles occur in the Rubinow method, but at different energy values. A criterion is suggested for avoiding the irregular behavior due to these poles by making an appropriate choice of either the Kohn or the Rubinow formula at a given energy. The formal discussion is illustrated by some computed results for S-wave scattering by an attractive exponential potential. (auth)

50028 REARRANGEMENT COLLISIONS: EFFECT OF CORE TERMS, NONORTHOGONALITY, AND CONSERVATION OF PARTICLE FLUX ON APPROXIMATE THEORIES. Truhlar, Donald G.; Cartwright, David C.; Kuppermann, Aron (California Inst. of Tech., Pasadena). Phys. Rev., 175: 113-33(Nov. 5, 1968).

Several first-order methods for rearrangement collisions are compared by applying them all to the same problem: electron-exchange scattering off the hydrogen atom. The methods considered are Born–Oppenheimer (BO); Bates–Bassel–Gerjuoy–Mittleman (BBGM); and Ochkur (O) with its modification by Rudge and Bely. Whenever possible, they are compared with close-coupling calculations or polarized-orbital calculations. The BO approximation gives better results if the core term is retained, indicating that this inclusion helps to achieve a cancellation of errors. The BBGM first-order method is found to give reasonable integral and differential cross sections at intermediate energies but not at low energies. The methods of Ochkur and Rudge give improved integral cross sections, but at low energies the differential cross sections may be poor. The unitarization procedure of Seaton and Bely is extended to calculate exchange scattering off neutral systems but only slightly improves the Ochkur–Rudge (OR) results. None of the methods examined is satisfactory in all regards. Several other improved methods are also reviewed. (auth)

50029 ELASTIC SCATTERING OF LOW-ENERGY ELECTRONS FROM METASTABLE HELIUM. Sklarew, Ralph C.; Callaway, Joseph (Louisiana State Univ., Baton Rouge). Phys. Rev., 175: 103-12(Nov. 5, 1968).

The cross section for the elastic scattering of electrons in the energy range 0.003 to 10.0 eV by metastable helium atoms in the 2^3S state has been computed using various forms of the polarized-orbital method. A low-energy spin-flip cross section is also obtained. The perturbed atomic wavefunctions required in the polarized-orbital method were obtained by solving the coupled equations of Hartree–Fock perturbation theory. It is shown that the adiabatic polarization potential produces an effective interaction which is too strongly attractive, whereas if the polarization effect is compensated by the distortion potential of nonadiabatic origin, the interaction is too repulsive. (auth)

50030 RADIATIVE MEAN-LIFE MEASUREMENTS OF SOME ATOMIC-HYDROGEN EXCITED STATES USING BEAM-FOIL EXCITATION. Chupp, E. L.; Dotchin, L. W.; Pegg, D. J. (Univ. of New Hampshire, Durham). Phys. Rev., 175: 44-50(Nov. 5, 1968).

The beam-foil excitation method has been used to measure the radiative mean lives of the 2p and 3p states of atomic hydrogen. The results obtained were $(1.60 \pm 0.01) \times 10^{-9}$ sec and $(5.5 \pm 0.2) \times 10^{-9}$ sec, respectively. A study of the results of this experiment has led to the following conclusions: (a) the Lyman-α decay curves are best fitted by the sum of two exponential terms whose characteristic decay times correspond to spontaneous decay of the 2p state and repopulation of this state by higher states, (b) the shapes of the Lyman-α decay curves vary with foil thickness, and (c) the ion energy loss in the foils used in this experiment changes with the age of the foil. A review of previous measurements on atomic-hydrogen radiative mean lives is also made and compared with theory. (auth)

50031 HYPERFINE STRUCTURE OF THE 2^3P LEVEL IN ^{3}He. Hambro, Lars (Univ. of California, Berkeley). Phys. Rev., 175: 31-3(Nov. 5, 1968).

The hyperfine structure levels of the 2^3P state of ^{3}He (at zero magnetic field) are given by the eigenvalues of a matrix whose elements are expressed in terms of three integrals, which are calculated using Hylleraas-type wavefunctions. (auth)

50032 COINCIDENCE MEASUREMENTS OF KRYPTON–KRYPTON COLLISIONS. McCaughey, M. P.; Knystautas, E. J.; Everhart, E. (Univ. of Connecticut, Storrs). Phys. Rev., 175: 14-19(Nov. 5, 1968).

In collisions of Kr^+ ions with Kr atoms at keV energies, both particles from the same encounter are recorded in coincidence. The charge states m of the scattered particle and n of the recoil particle are measured, and the relative probability of such an (m,n) event is determined, together with the inelastic energy loss associated with that event. These data are analyzed using the statistical model of Everhart and Kessel. This model, which assumes m and n to be statistically independent of each other, fits the data fairly well. Ionization potentials for Kr^{+5} through Kr^{+9} are estimated from the data curves as interpreted by the statistical model. There is an active region in the Kr^+–Kr data at 25-keV incident energy and 9° scattering where the inelastic energy changes suddenly, and other anomalous effects are found. This is compared and contrasted with active regions previously found in Ne^+–Ne and Ar^+–Ar data. (auth)

50033 POLARIZATION EFFECTS IN INDUCED EMISSION OF BREMSSTRAHLUNG. Kolbenstvedt, Hans; Olsen, Haakon A. (Univ. of Trondheim, Norway). Phys. Rev., 175: 11-13(Nov. 5, 1968).

The effect of induced bremsstrahlung is studied with respect to photon intensity and polarization. It is shown that the polarization effect is of importance when net induced emission occurs. (auth)

50034 PERIODIC DEPENDENCE OF THE ELECTRONIC CROSS SECTION FOR ENERGETIC HEAVY IONS IN SOLIDS. El-hoshy, Ahmed H.; Gibbons, James F. (Stanford Univ., Calif.). Phys. Rev., 173: 454-60(Sept. 10, 1968).

Measurements of the electronic stopping cross section for heavy ions in various substrates indicate a periodic dependence on the atomic number of the impinging ion. This work provides an explanation of the observed behavior. The periods are observed to correspond to unit steps in the principal quantum number of the outermost orbit of the incident ion, with a peak in the stopping cross section occurring roughly for the ion with a half-filled outer shell. As the number of electrons in the outermost shell is increased, the contribution to energy loss increases. However, beyond a certain point the increasing number of electrons in the outer shell is offset by the increased binding energy of the electrons and the decreased radii of the orbits, reducing the effective number of outer electrons. Use is made of the Firsov model with appropriate values for the effective charge to give stopping cross sections that agree rather well with channeling measurements in both crystalline silicon and tungsten. The same approach can be extended to explain similar behavior in amorphous as well as other crystalline substrates. (auth)

50035 GENERALIZED OSCILLATOR STRENGTHS OF THE HELIUM ATOM. I. Kim, Yong-ki; Inokuti, Mitio (Argonne National Lab., Ill.). Phys. Rev., 175: 176-88(Nov. 5, 1968).

The generalized oscillator strengths $f_n(K)$ ($\hbar K$ = momentum transfer) for the transitions of He from its ground state to excited

states n = 2^1P, 3^1P, 2^1S, and 3^1S are computed from the Weiss correlated wave functions of over 50 terms each. For $(Ka_0)^2 \lesssim 2$ (a_0 = the Bohr radius), the results by two alternative formulas, corresponding to the "length" and "velocity" formulas in the optical limit, agree with each other within 0.5% for the 2^1P and 2^1S excitations, and within 1.5% for the 3^1P and 3^1S excitations. Our $f_{2^1P}(K)$ is in accord with electron-scattering experiments by Lassettre and his co-workers. For $(Ka_0)^2 \gtrsim 0.2$, our $f_{2^1S}(K)$ departs from experimental data at 500 eV, but its slope at K = 0 is consistent with experiment. The results are very probably accurate within a few percent, and thus should provide a sound basis to test the validity of the (first) Born approximation. The representation of the Born excitation cross section for charged-particle impact is greatly simplified by a generalization of the Bethe procedure; it is shown that a few definite parameters can convey the essential content of the Born approximation. As an illustration, the cross sections for the excitations to the four states in He are evaluated and compared with experiments. (auth)

50036 QUASI-ELASTIC EJECTION OF AN ELECTRON BY A FAST ELECTRON (e,2e) FROM ATOMS, MOLECULES, AND VERY THIN FILMS. Neudachin, V. G.; Novoskol'tseva, G. A.; Smirnov, Yu. F. (Inst. of Nuclear Physics, Moscow). Zh. Eksp. Teor. Fiz., 55: 1039-46(1968). (In Russian).

The possibilities of obtaining new information on electron states of atoms, molecules, and thin (~60 to 100 Å) crystal films in experiments on quasi-elastic ejection of valency electrons from a target by 10- to 50-keV electrons are discussed. It is assumed that both emerging electrons are recorded by the coincidence technique ((e,2e) process, which is an analogue of the (p,2p) nuclear reaction). The feasibility of the method is demonstrated in several concrete cases, such as the hydrogen atom, H_2 and N_2 molecules, and Al, KCl, Cu single crystals. The calculations are performed in the impulse approximation. The angular-correlation function of the emitted electrons is found to be very sensitive to such details of the electron wave functions as hybridization of s and p orbits in the molecules, type of bond between the electrons and crystal lattice etc. Although high energy resolution and high beam intensities are required, the experiment appears to be quite feasible. (auth)

50037 TWO-PHOTON BOUND–BOUND TRANSITIONS IN A COULOMB FIELD. Zon, B. A.; Manakov, N. L.; Rapoport, L. P. (Voronezh State Univ., USSR). Zh. Eksp. Teor. Fiz., 55: 924-30 (1968). (In Russian).

A method is proposed, which can be employed for obtaining analytic expressions of two-photon process amplitudes in a hydrogen atom involving bound–bound transitions. The method is based on application of a special integral representation of the Coulomb Green function. The amplitude of the two-photon process can be expressed in terms of a hypergeometric function. As examples, cross sections are given for coherent scattering of light off 1s, 2s, and 2p levels and for combinational scattering involving the 1s ⇌ 2s and 1s ⇌ 3d transitions. (auth)

50038 EXCITATION OF K II RESONANCE LINES IN SLOW COLLISIONS BETWEEN K^+ IONS AND HELIUM ATOMS. Matveev, V. B.; Bobashev, S. V.; Dukel'skii, V. M. (Ioffe Inst. of Physics and Tech., Leningrad). Zh. Eksp. Teor. Fiz., 55: 781-6(1968). (In Russian).

The relative intensities of the λ 600.7, 607.9, and 612.6 Å K II resonance lines excited in collisions between positive potassium ions and helium atoms are measured for K^+ ion energies between 0.8 and 9.0 keV. The experimental excitation curve for the K II λ 600.7 Å line at energies above 1.3 keV coincides with the theoretical curve calculated by the Landau–Zener formula. The relative intensities of the K II λ 600.7, 607.9, and 612.6 Å lines (4 : 1 : 1) indicate that the probability for excitation of the singlet resonance level $^1P_1$ is greater than that for the triplet level $^3P_1$. (auth)

50039 SYMMETRIC RESONANCE CHARGE EXCHANGE OF MULTICHARGED IONS. Latypov, Z. Z.; Fedorenko, N. V.; Flaks, I. P.; Shaporenko, A. A. (Ioffe Inst. of Physics and Tech., Leningrad). Zh. Eksp. Teor. Fiz., 55: 847-53(1968). (In Russian).

An experimental method is developed for studying inelastic atomic collisions involving low-energy multicharged ions. The method is based on registration of slow ions produced in the gas by a pulsating multicharged ion beam passing through it. The slow ions are extracted from the gas target by means of a pulsating electric field. The pulses of the primary ion current and of the field extracting the slow ions are separated by a period of time such that slow-ion formation occurs in absence of the field and their extraction by the field occurs in the absence of the primary beam. The method is employed for measuring effective cross sections for symmetric resonance charge exchange of doubly and triply charged neon, argon, and xenon ions at accelerating voltages of 200 to 3000 V. The results of measurement of the effective cross sections for doubly charged ions are compared with the data of other authors and with the theoretical calculations. No information is available in the literature on cross sections for symmetric resonance charge exchange in the indicated energy range. (auth)

50040 THEORY OF HIGH-ENERGY ION–ATOM COLLISIONS WITH ELECTRON EXCHANGES. Hahn, Yukap (Univ. of Connecticut, Storrs). Phys. Rev., 175: 197-204(Nov. 5, 1968).

The high-energy scattering equations are derived in the impact parameter representation which treat the rearrangement channels correctly. An exact set of coupling potentials is obtained, and their structure is studied specifically for the charge-exchange processes. Several approximation methods are discussed. The variational principle with the bound property is introduced in the impact parameter formalism which provides a simple method of precisely evaluating the high-energy scattering amplitudes. (auth)

50041 ELASTIC SCATTERING OF SLOW ELECTRONS BY TWO-ELECTRON IONS. McDowell, M. R. C. (Goddard Space Flight Center, Greenbelt, Md.). Phys. Rev., 175: 189-96(Nov. 5, 1968).

A one-channel model, previously used for He, is extended to allow calculation of elastic scattering by H^- and Li^+ at energies up to 3 Ry. Nonseparable ground-state wave functions are used, allowance being made for exchange, and dipole and quadrupole polarization potentials. Results for Li^+ are in good agreement with quantum-defect-method values. Calculated differential cross sections for elastic scattering by H^- at energies of ½ and 1 Ry are presented. Deviations from Coulomb scattering are marked. Phase shifts (l = 0, 1) for higher members of the isoelectronic sequence ($4 \leq Z \leq 10$) are given at threshold and 1 Ry. (auth)

50042 MASS STOPPING POWERS ESPECIALLY OF PLASTICS IN RELATION TO THEORY. Cross, Fredrick Thomas. Rochester, N. Y., Univ. of Rochester, 1967. 174p.

Thesis.

The air pressure in chambers of graphite, aluminum, copper, and a few graphited plastics was reduced from atmospheric to approximately 15 cm Hg. The variations with pressure of the ionization currents were compared, according to a method by Whyte, in order to deduce the mass stopping powers. Copper, aluminum, and graphite are "associative" ionization chambers providing a check on the data and a comparison to previous measurements. To remove any difficulties associated with the mass energy absorption coefficients, cobalt-60 was selected as the irradiating source. The experimentally determined mass stopping powers and the variation with pressure of the ionization currents are compared to the predictions of the early Bragg–Gray–Laurence theory, and the much later and improved theory of Spencer and Attix. The theoretical calculations are based on the tacit assumption that Bragg's addition law for mixtures is applicable to the plastics. In the main, the mass stopping powers of graphite and the plastics are found to be predicted equally well by either theory whereas the Spencer–Attix theory is the better of the two for aluminum and copper. The variation of the ionization current with pressure, however, is in closer agreement with the Spencer–Attix theory; the Bragg–Gray–Laurence theory predicting an invariancy with pressure. The measured stopping power of teflon is 2% higher than the Spence–Attix predictions based on an average excitation–ionization potential for the fluorine atom of 113 eV. If this potential is reduced to 100 eV (a not improbable value) the discrepancy in the measured and calculated values would be removed. Finally, it is shown that Whyte's method is capable of producing stopping powers that are in close agreement with the Spence–Attix theory even though the cavity sizes are not identical. The conditions under which the method may no longer be applied, as well as a means for checking, are included. (TSS) (Diss. Abstr.)

50043 MOLECULAR BEAM SCATTERING AS A ROUTE TO THE INTERMOLECULAR POTENTIAL. Bernstein, R. B. (Univ. of Wisconsin, Madison). Pontif. Acad. Sci. Scr. Varia, 31: 25-71(1967).

A review of work on molecular beam scattering is presented. The effects of the intermolecular potential on cross sections are discussed in particular. (M.O.W.)

50044 USE OF METALLIC FILM FOR THE CONVERSIONS OF $H_i^+ \rightarrow H_i^0$ AND $H_i^+ \rightarrow H_i^+$ IN THE ENERGY RANGE 7 TO 40 keV. Morita, Kenji; Akimune, Hideo; Suita, Tokuo (Osaka Univ.). Technol. Rep. Osaka Univ., 18: 27-35(Mar. 1968).

Absolute current of a neutral beam was measured by a method of using a metallic film. The experimental error of this method is, in principle, within 2%. The energy loss in the film on H^+ incidence agrees approximately with that on the H^0 incidence within the experimental error. The relative intensities of charged components coming from the film on the H^0 incidence show good agreement with those on H^+ for films thicker than 300 Å. The relative yield

on the conversion ($H^0 \rightarrow H^+$) for 37 $\mu g/cm^2$ Cu film varies from 10 to 25% with the incident energy when supported on Ni mesh. The relative yield on the conversion ($H^+ \rightarrow H^0$) also increases from 1.8 to 20% with the incident energy. The measured full width at half maximum of the energy distribution of emergent particles for Cu film of 34 $\mu g/cm^2$ increases from 1.4 to 2.4 keV as the incident energy increases. (auth)

50045 OSCILLATOR STRENGTHS FOR HIGH-LEVEL TRANSITIONS IN HYDROGEN. Menzel, D. H. (Harvard Coll. Observatory, Cambridge, Mass.). Nature (London), 218: 756-7(May 25, 1968).

Transitions between high quantum levels of atomic hydrogen can produce spectral lines in the radio region, and such emissions have been detected from hydrogen gas in various radio sources. Theoretical interpretation of such observations requires a knowledge of the oscillator strengths $f_{n+c,n}$ for transitions described by the quantum transition $n + c \rightarrow n$. Certain aspects of the theory are discussed, together with apparent paradoxes. (UK)

50046 ENERGY OF THE EXCITED STATES OF HELIUM. Ivanova, A. N.; Safronova, U. I.; Kharitonova, V. N. Opt. Spectrosc. (USSR) (Engl. Transl.), 24: 355-9(May 1968).

Translated from Opt. Spektrosk., 24: 660-2(May 1968).

The field form of the perturbation theory is applied to two-electron atomic systems. The excited states of He (configurations 1s2s, 1s3s, 1s4s, 1s5s, 1s2p, 1s3p, and 1s3d) are investigated. The results are presented in the form $E_2 = E_2Z^2 + \Delta E_1 Z + \Delta E_2$. For Z = 2 a comparison is made with experiment. (auth)

50047 ELECTRIC FIELD DEPENDENCE OF POSITRONIUM FORMATION IN MOLECULAR SUBSTANCES. Feibus, Howard. New York, New York Univ., 1967. 76p.

Thesis.

Positronium (Ps) can be formed whenever positrons, on slowing down in a substance, pass through an Ore gap, i.e., a range of energies just below the ionization threshold of the substance of width comparable to the Ps binding energy. The time evolution of the energy distribution of the positrons below the ionization threshold in the presence of an external electrostatic field has been studied and it is found that (1) the field induces diffusion out of the Ore gap, which reduces Ps formation, (2) the overall heating effect of the field on the positrons increases Ps formation. Depending on the magnitude of the relevant cross sections, (1) can outweigh (2) at small fields and cause a significant decline in the Ps formation. At field strengths greater than a characteristic value, (2) becomes the dominant effect. In this way measurements of the field dependence of Ps formation can give access, at the energies of the Ore gap, to the cross sections of Ps formation and of positron energy loss and scattering in matter. The results of the theory are applied to substances for which experimental data are available and the relevant cross sections are determined. (Diss. Abstr.)

50048 CHARGE EXCHANGE. Ciobotaru, D. (Univ. of Bucharest). Stud. Cercet. Fiz., 20: 231-72(1968). (In Rumanian).

The charge exchange that may take place between a positive ion and a neutral atom or molecule, involves the removal of electrons from the target atom by the kinetic ion. It is not identical with processes taking place during the collision of electrons with atoms and should not be confused with the recombination process which yields a new molecule. The phenomenon played an important role in the study of the canal rays and is of special interest in the determination of the velocity distribution of positive ions in the plasma and their mobility in external fields. Theoretical study of the process involves primarily calculation of its cross section and determination of the angular distribution of the resulting particles. The calculation methods used are based on approximations for either relatively high or low ion–atom velocities. The approximations developed by R. McCarroll and M. B. McElroy for a nonresonant charge exchange were more closely examined, together with a nonsymmetric resonant transfer process, in which the system losing the electron is not identical with the recipient system. The experimental methods used to determine the cross section are described. (Review article, 86 references). (TTT)

50049 A BEAM STUDY OF $N_2^+ + H_2, HD, D_2$ REACTION DYNAMICS. Gentry, William Ronald. Berkeley, Calif., Univ. of California, 1967. 75p.

Thesis.

An ion beam–collision cell method was used to measure the product energy and angular distributions from reactions of N_2^+ with H_2, HD, and D_2 in the primary-ion energy range 25 to 135 eV. The data include three contour maps each for the H_2 and D_2 experiments (taken at low, intermediate, and high energies) showing the entire distribution of product intensity in the center-of-mass coordinate system. The distributions have a crater-like shape around the center-of-mass point. At large scattering angles the intensity varies slowly with angle, and the velocity at the rim of the crater is independent of angle in the center-of-mass system. All of the distributions have a peak at 0° scattering angle, which shows little spreading in energy or angle over the spread in the primary ion beam. The intensity of this peak is 3 to 500 times that for the large-angle scattering. Kinematic analysis of the distributions shows that all product ions are formed with high excitation energies. The amount of transfer of kinetic energy of the reactants to excitation energy of the products is found to be ~1.75 eV for the large-angle scattering, independent of the primary ion energy. For the small-angle scattering the energy transfer agrees with predictions of the stripping model for collisions at low energies, but at high collision energies it reaches a constant maximum value of ~2.5 eV. This result is interpreted as evidence for $N_2 + H^+$ as the principal dissociation products of N_2H^+. Only isolated features of the product-ion distributions are found to agree with simple collision models, and at high energies strong recoil is kinematically required by the data, even for the forward scattering peaks. (Diss. Abstr.)

50050 THE MEASUREMENT OF COLLISION CROSS-SECTIONS FOR ENERGY TRANSFER BETWEEN N = 4 STATES OF HELIUM. Abrams, Richard Lee. Ithaca, N. Y., Cornell Univ., 1968. 114p.

Thesis.

Cross sections have been measured for collisional transfer of excitation between the n = 4 atomic states of helium. A pure helium gas laser was used to selectively perturb the excited-state population distribution in a pure helium gas discharge contained in a sample cell internal to the laser cavity. The 4^3P or 4^3F level population (depending on which laser transition is used) was directly perturbed and the population changes of laser levels and nonlaser levels were measured by monitoring the laser-induced changes in the sidelight emission intensity from the sample cell for the various spectral lines. The measured intensity changes were related to the population changes through the calculated spontaneous emission rates. An analytical formulation of the problem results in a set of rate equations which were used to relate the population changes of the nonlaser levels to the laser-level population changes. A fit of the theoretical curves to the data resulted in the following cross sections: $q_{4^3P-4^3S} = 0.35 \times 10^{-15}$ cm^2; $q_{4^3P-4^3D} = 0.99 \times 10^{-15}$ cm^2; $q_{4^3F-4^3D} = 18 \times 10^{-15}$ cm^2; $q_{4^3F-4^3D} = 10.5 \times 10^{-15}$ cm^2. It was shown that the Wigner spin rule is obeyed for collisional transfer among the n = 4 levels except when the 4F levels are involved. This is in agreement with previous theoretical predictions. (Diss. Abstr.)

50051 RESONANCE TRANSFER OF EXCITATION AND MEASUREMENT OF THE HYPERFINE STRUCTURE OF THE ATOM. Chibisov, M. I. Dokl. Akad. Nauk SSSR, 180: 1094-5 (June 11, 1968). (In Russian).

The hyperfine state resulting from electron and nuclear spin of the atom may be changed by substitution of electrons with opposite spins, resulting from the collision of two atoms. It is shown that the electron spin of the ground state may be changed also by resonance transfer of excitation. At low nuclear rates the probability of this process is much larger than that of the electron exchange. The resonance transfer of excitation is defined as the exchange of electron state during the collision of two similar atoms, the states of which differ by one unit in the absolute value of the orbital moment of the electron. If the distance between the nuclei is large, the dipole–dipole interaction is the basic process. In case of collision of atoms with antiparallel electron spins, the excitation transfer reverses the direction of both p and s states. An expression was derived to determine the probability of the reversal of the electron spin direction. (TTT)

50052 COUPLING OF THE DIRECT AND THE EXCHANGE SCATTERING IN SLOW ION–ATOM COLLISIONS. Janev, R. K. (Boris Kidric Inst., Belgrade). Fizika (Zagreb), 1: 1-9(July 1, 1968).

The effect of the direct interaction in a slow ion–atom collision on the exchange amplitude is considered. A modified formula is obtained for the A^{2+}–A resonant charge-exchange cross section and calculations are made for the case of A being an inert gas atom. The polarization (ion) capture radius and the elastic-scattering cross section are estimated at thermal energies. (auth)

50053 REACTIONS OF EXCITED ATOMS AND MOLECULES WITH ATOMS AND MOLECULES. I. EXCITED RARE GAS ATOMS AND HYDROGEN. Hotop, H.; Niehaus, A. (Univ., Freiburg, i. B.). Z. Phys., 215: 395-407(1968).

Ionizing collisions of long-lived excited particles with atoms and molecules are studied by a crossed-beam technique. For the first time reactions of atoms in high Rydberg states are included in the investigation. Relative cross sections are reported for the production of the ions RH^+, RH_2^+, and H_3^+ by collisions of excited rare gas atoms R^* with H_2. With HD as the target molecule the isotope ef-

fect for the production of RD^+ and RH^+ has been determined. In the case of argon and krypton, ions are produced only by the high Rydberg states, whereas in the case of helium and neon only the metastable states contribute to a measurable extent. The data indicate, that the reaction mechanism is different in principle for metastable and highly excited atoms. Simple models are proposed to explain the experimental results. (auth)

50054 PERTURBATION THEORY FOR EXCHANGE INTERACTIONS BETWEEN ATOMS AND MOLECULES. I. Ritchie, A. B. (Univ. of Virginia, Charlottesville). Phys. Rev., 171: 125-7(July 5, 1968).

A perturbation theory has been developed for interatomic or intermolecular forces with exchange. The method requires the use of label-free operators in a representation of nonorthogonal, antisymmetrized states. The introduction of this representation shows that the explicit construction of a complete orthogonalized set is unnecessary. The antisymmetry of the exact wave function is preserved to all orders, and hence exchange is treated exactly. (auth)

50055 ON THE THEORY OF VAVILOV–CHERENKOV RADIATION DUE TO A MAGNETIC MONOPOLE. Kukanov, A. B. Opt. Spectrosc. (USSR) (Engl. Transl.), 24: 323-4(Apr. 1968).

Translated from Opt. Spektrosk., 24: 614-16(Apr. 1968).

The problem of Vavilov–Cherenkov radiation by a magnetic charge in a transparent, isotropic dielectric has been examined by Frank. Some generalization of Frank's equations are given here. (M.H.R.)

50056 CALCULATING THE REFLECTION OF FAST ELECTRONS. Romanovskii, V. A. Ukr. Fiz. Zh., 12: 1557-9(1967). (In Russian).

The diffusion approximation of the Archard model for calculating electron reflection coefficients assumes an isotropic angular distribution of electrons at a certain distance x_d from the surface as a result of scattering. From a comparison of calculated and experimental data, it is obvious that the divergence between the two sets of data increases with increasing angle of incidence. If attenuation of the incident electron beam in the surface layer is taken into account according to Everhart, the approximation is improved, but there is still a divergence between the experiment and calculated results. (TTT)

50057 THE L EMISSION SPECTRUM OF Tm. Deodhar, G. B.; Varma, P. P.; Singh, R. B. (Univ. of Allahabad, India). J. Phys., B (London), 1: 997-1000(Sept. 1968).

A detailed study of the L emission spectrum of thulium was made with the aid of a 40-cm curved-crystal spectrograph of the transmission type. As a result five diagram lines for this element were measured and reported for the first time. The line λ 1441.20 x.u. corresponds to the dipole transition $L_{III}O_I(\beta_7)$, while the lines λ 1518.84 x.u. and λ 1497.32 x.u. correspond to the octupole and quadrupole transitions $L_{II}M_V$ and $L_{III}N_{II}$, respectively. The remaining two new lines λ 1230.59 x.u. and λ 1341.15 x.u. are due to the non-quadrupole transitions L_IO_I and $L_{II}N_{II}$, respectively. Four transitions, viz. $L_{II}O_{IV}(\gamma_6)$, $L_IM_{IV}(\beta_{16})$, $L_IM_V(\beta_9)$ and $L_IO_{IV,V}$ already reported only by Sakellaridis (1953 and 1955) were confirmed. The lines $L_{III}O_{IV,V}(\beta_5)$ and $L_{III}M_I(l)$ also reported only by Sakellaridis could not be confirmed. The energy of the O_I level of thulium was re-evaluated. (auth)

50058 ENERGY SPECTRUM OF PROTONS PRODUCED IN COLLISIONAL DISSOCIATION OF FAST H_2^+ IONS. Caudano, R.; Delfosse, J. M. (Louvain Univ., Belg.). J. Phys., B (London), 1: 813-21(Sept. 1968).

Energy distributions of protons produced in dissociative collisions of H_2^+ with H_2, Ar, and Xe were measured in the forward direction at 10 keV. An experimental method giving the corresponding excess kinetic energy spectrum in the center-of-mass system of H_2^+ is briefly discussed. The measured spectra are explained in terms of electronic and vibrational transitions to dissociative states of the H_2^+ molecular ion. The dissociation cross section by vibrational transitions in the $1s\sigma_g$ state is estimated to be, respectively, $\sigma_v = 1.4 \times 10^{-18}$ cm^2, $\sigma_v = 4.3 \times 10^{-18}$ cm^2, and $\sigma_v = 5 \times 10^{-18}$ cm^2 for hydrogen, argon, and xenon targets. The dependence upon the target density is interpreted as a double collision dissociation process of the type $H_2^+ \rightarrow H_2^{3*} \rightarrow H^+$. The influence of ion source parameters is also studied. Comparison is made with theory, and the agreement is found to be good if allowance is made for the dependence of dissociation upon the internuclear axis orientation. (auth) (UK)

Cosmic Radiation

Refer also to abstract 49155.

50059 LOCALIZATION OF THE AXES OF INDIVIDUAL EXTENSIVE AIR SHOWERS OF COSMIC RADIATION. Jatczak, Jerzy (Lodz Univ., Poland). Nukleonika, 13: 827-43(1968).

A method has been developed for localizing the axes of individual showers by measuring the ratios of the densities of charged particles in the shower. With the assumption that the age parameter s = 1.25, nomograms were drawn for localizing the axes of showers in a 75-meter circle. The axes of 9831 showers were localized and an experimental histogram was made of the radial distribution of the shower frequency. The parameters of this distribution were determined. (auth)

50060 OBSERVATION OF HIGH-ENERGY COSMIC GAMMA RAYS. Clark, G. W. (Massachusetts Inst. of Tech., Cambridge); Garmire, G. P.; Kraushaar, W. L. Astrophys. J., 153: L203-7(Sept. 1968).

High-energy gamma radiation was detected from a band in the sky coincident with the plane of the Galaxy by a detector flown on the third Orbiting Solar Observatory (OSO 3). The intensity of the radiation along the galactic equator has a broad maximum in the direction of the galaxtic center. In addition, evidence for an isotropic component was found. (auth)

50061 COSMIC RAYS IN GOLD MINES. Wolfendale, A. W. (Univ. of Durham, Eng.). Nature (London), 219: 1215-17(Sept. 21, 1968).

Four experiments set up underground at the University of Utah to detect neutrinos are discussed. The results will be relevant to the search for the intermediate boson and the understanding of reactions in the solar core. (auth) (UK)

50062 DETERMINATION OF COSMOGENIC PRODUCTION RATES OF ^{10}Be AND ^{7}Be IN THE ATMOSPHERE FROM ACTIVITY MEASUREMENTS IN SOIL LAYERS. Moeller, P.; Wagner, K. (Hahn-Meitner-Institut, Berlin). Z. Naturforsch., 23a: 1221(Aug. 1968).

The cosmogenic production rates of ^{10}Be and ^{7}Be in the atmosphere have been derived from activity measurements of the Be isotopes in soils. The ratio of the spallation yields was found to be $^{10}Be/^{7}Be = 0.7 \pm 0.3$. (auth)

50063 DYNAMICAL PROPERTIES OF COSMIC RAYS. Parker, E. N. (Univ. of Chicago). pp 707-54 of Nebulae and Interstellar Matter. Middlehurst, Barbara M. (ed.). Chicago, University of Chicago Press, 1968.

The purpose of this chapter is to present cosmic rays in their astrophysical role. The interstellar medium is thought of as a composite fluid, consisting of the optically detected interstellar gas and the suprathermal cosmic-ray gas that dominates many dynamical properties of the Galaxy. The two components would move quite independently of each other were it not for the presence of weak magnetic fields (from 10^{-6} to 10^{+5} G). The general magnetic field ties the two gases together into a composite medium with dynamical consequences that have been pointed out only very recently. After a survey of the observations, implications for the age, origin, and extent of the cosmic-ray gas are discussed. Some immediate dynamical consequences of the presence of the cosmic-ray gas in the Galaxy are pointed out. (W.D.M.)

50064 HIGH-FREQUENCY TURBULENCE SPECTRA OF A PLASMA AND ACCELERATION OF SUB-COSMIC RAYS. Pikel'ner, S. B.; Tsytovich, V. N. (State Astronomical Inst., Moscow). Zh. Eksp. Teor. Fiz., 55: 977-89(1968). (In Russian).

Nonlinear equations describing the interaction of high-frequency turbulent pulsations of a plasma of the Langmuir type are employed for determining the equilibrium spectrum of plasma turbulence in the region in which energy is transferred along the spectrum. It is assumed that a stationary source generates turbulent energy in the region of very large values of k; this energy is transferred to a region with $k = k_0$, which is the basic turbulence dimension, and decays in this region. In the transfer region $k \gg k_0$ an approximate power spectrum $W_k \sim k^{-\nu}$ is derived. For strong-enough turbulence, when absorption and scattering processes are insignificant, $\nu = 2.84$ and in the general case it can rise to $\nu = 4$. Application of the results to astrophysical problems, and in particular to the problem of acceleration of sub-cosmic rays, is discussed. (auth)

50065 COSMIC RAYS AND RADIATION BELTS. Kondo, Ichiro. Tokyo Daigaku Uchu Koku Kenkyusho Hokoku, 2: 1234-55(Sept. 1966). (In Japanese).

Research is reviewed, based on space observations of (1) accelerations of the charged particles of the Sun and their methods of propagation and diffusion through interplanetary space, (2) problems relating to the origin of galactic cosmic rays, (3) modulation of cosmic-ray particles by the interplanetary plasma and

its magnetic field, and (4) structure of the radiation belts and the origin and acceleration mechanisms of the trapped particles. Difficulties arising from the position of the radiation belts over Japan for the study of the radiation belts by sounding rockets are shown. It is also emphasized that the study of the charged particles in the space under the inner belts can yield important information regarding the decay and the growth of the inner belt. (Meteorol. Geoastrophys. Abstr.)

50066 EXPERIMENT TO DETECT PRIMARY COSMIC GAMMA RAYS. Cobb, Roland William. Rochester, N. Y., Univ. of Rochester, 1968. 128p.

Thesis.

An attempt was made to detect primary, point-source cosmic gamma rays using a spark chamber counter system. Evidence is presented for a possible point-source gamma-ray flux from the constellation of Cygnus. It is shown that, during the experiment, an unexpected shift in the counting rate occurred for a class of detected events which could not be identified as being gamma ray initiated. The results of an examination of the properties of all events detected during the shift are described. (Diss. Abstr.)

Direct Energy Conversion

50067 (JUL-508-TP) MESSUNG DES ELEKTRONENEMISSIONSSTROMES VON WOLFRAM IN EINEM CAESIUM-PLASMA. (Measurement of the Electron Emission Stream of Tungsten in a Cesium Plasma). Miyake, Masanobu; Bundschuh, Vinzenz (Kernforschungsanlage, Juelich (West Germany). Institut fuer Technische Physik). Dec. 1967. 38p. (In German). Dep.

The application of the Marchuk method for the determination of the work function of electrons of surface emitters was studied. The results showed that the Marchuk method was applicable to plate-shaped samples. At cesium bath temperature under 473°C, the electron emission current is small with respect to the discharge current. At cesium bath temperatures over 473°C, the ratios in the plasma–sample boundary layer are complex. The measurement of the electron emission current during the cooling period of the sample shows the possibility of measuring the work function at cesium bath temperatures over 473°C. The work function of a tungsten single crystal of the plane (110) was measured and the results are graphed. (tr-auth)

50068 (NP-17604) THERMIONIC RESEARCH AND DEVELOPMENT PROGRAM. Quarterly Progress Report No. 1. Jacobson, D. L.; Hamerdinger, R.; Campbell, A. (Electro-Optical Systems, Inc., Pasadena, Calif.). July 12, 1968. Contract 952217. 71p. (EOS-4006-Q-1).

For Jet Propulsion Lab., California Inst. of Tech., Pasadena.

The electrode materials evaluation reviewed includes work on molybdenum and rhenium single crystals and a vapor-deposited rhenium variable parameter test vehicle. The low-temperature (1700 to 1800°K) cylindrical converter work includes that on converter design and thermal mockups. (M.H.R.)

50069 TUBE-TYPE ATOMIC CELL. Hayashi, Yoshibumi (to Matsushita Electric Industry Co., Ltd.). Japanese Patent 1967-22873. Dec. 25, 1967. Filed May 31, 1961.

An improved atomic cell, consisting of a p-n junction semiconductor and a radioactive material, is proposed; by increasing the p–n junction area irradiated, the electromotive force and hence the power output is greatly increased. The semiconductor film, having the p–n junction, and the radioactive film are attached together, and the resultant sheet is rolled. (NSA of Japan)

50070 CERTAIN ELECTRODYNAMIC EFFECTS IN MHD GENERATOR CHANNELS. Bityurin, V. A.; Kovbasyuk, V. I.; Medin, S. A. Izv. Akad. Nauk SSSR, Mekh. Zhidk. Gaza, No. 3, 3-8(May-June 1968). (In Russian).

Combined effects due to the inhomogeneity of the flow and electrical losses in the presence of anisotropy of plasma conductivity are analyzed for the case of an MHD generator with finite dimensional parameters. (R.V.J.)

50071 ANALYSIS OF THE REGION OF PLASMA PERTURBATION AREA NEAR ELECTRODES. Lyubimov, G. A.; Mikhailov, V. N. Izv. Akad. Nauk SSSR, Mekh. Zhidk. Gaza, No. 3, 9-17 (May-June 1968). (In Russian).

The diffusion equation was used for studying the distribution of parameters in the region of plasma perturbation near the electrode surface. Depending on the dimensional parameters two regions can be present, one of ambipolar diffusion and the other of the space charge layer. Approximate solutions were found for these regions in the form of the principal expansion term along the parameter $\nu = (h/l_i)^2$ where h is the Debye length and l_i is the perturbation length. The solutions were used in the problem on potential distribution and charged-particle concentrations near the electrode surface during discharge between plane-parallel electrodes and dense weakly ionized gas. (R.V.J.)

50072 RADIATION-TYPE HEAT EXCHANGER. Nguyen Duc, Xuong (to Commissariat a l'Energie Atomique). British Patent 1,119,600. July 10, 1968. Priority date July 6, 1965, France.

This heat exchanger, particularly suited for MHD converters, includes a prismatic radiation chamber in which a first fluid will flow in the direction of the longitudinal axis. The chamber wall is made of a transparent material which will absorb none of the radiation emitted by the first fluid. This wall consists of juxtaposed elements each of which has the cross section of a convergent lens, a jacket of thermally insulating material surrounding the wall, and prismatic cavities parallel to the said longitudinal axis. Each of these cavities has one of its walls consisting of the curved face of one of the convergent lenses. Each of these cavities communicates with a compartment by way of a diaphragm which defines a narrow slot disposed in parallel relationship to the longitudinal axis of the radiation chamber and coinciding with the focal line of the corresponding lens. Each compartment is provided for a second fluid which will be at a temperature below that of the first fluid. The arrangement is such that the temperature of the second fluid will be caused to rise, in view of its close proximity to said focal line. (M.H.R.)

50073 CONTRIBUTIONS TO THE STUDY OF END EFFECTS ON THE FLOW IN MAGNETOHYDRODYNAMIC GENERATORS. Dragos, L. Rev. Roum. Math. Pures Appl., 12: 1193-1205 (1967). (In French).

The end effect of the electrodes of a MHD generator on fluid flows was investigated. Assuming similar conditions to those used by Sutton and Carlson, a method is developed allowing for approximations of any degree to be made for both the velocity and the electric fields. The exact solution of the problem reduces to the solution of a particular integral equation. The results are obtained by stating the problem in the language of Schwartz's distribution theory. (Rom. Sci. Abstr.)

Fluid Physics

Refer also to abstract 50150.

50074 (NYO-3863-9) THE ROLE OF LANDAU DAMPING IN CROSSED-FIELD ELECTRON BEAMS AND INVISCID SHEAR FLOW. Research Report 317. Briggs, R. J.; Daugherty, J. D.; Levy, R. H. (Avco-Everett Research Lab., Everett, Mass.). Sept. 1968. Contract AT(30-1)-3863. 72p. Dep. CFSTI.

Under certain circumstances the problem of the stability of low density crossed-field electron beams is precisely analogous to the problem of the stability of incompressible inviscid shear flows. The electron density, the drift velocity, and the potential correspond to the fluid vorticity, velocity, and the stream function respectively. The analogy is valid only for waves propagating in the direction of the unperturbed velocity. Neutrally stable normal modes of oscillation that are found when certain suitable step-function unperturbed electron density (vorticity) profiles are assumed seem to disappear when small gradients are present. In the context of a Laplace transform solution of the initial value problem, the vanishing normal modes can be found by analytic continuation of the solution onto another sheet of the cut complex ω plane. The "recovered" modes are found to be damped by a fluid-wave resonant interaction which closely resembles the Landau damping of plasma oscillations in warm plasmas by particle–wave resonance. An interesting feature of the neutral waves is that they have a negative energy and so are destabilized by the removal of energy from the system (for example, by slightly dissipative walls). The sign and magnitude of the Landau damping term is evaluated for a simple case and compared (for the electronic case) with the growth provoked by slightly lossy walls. (auth)

50075 NONISENTROPIC RECTILINEAR HYDROMAGNETIC FLOW. Gundersen, Roy M. (Univ. of Wisconsin, Milwaukee). Ann. Soc. Sci. Brux. Ser. 1, 82: 225-31(July 30, 1968).

Solutions of the system of equations which govern the one-dimensional unsteady flow of an ideal, inviscid, perfectly conducting compressible fluid, subjected to a transverse magnetic field, may be found by considering a single second-order nonlinear partial differential equation. A class of exact solutions of this latter equation is found for a particular entropy distribution. (auth)

50076 GENERAL SOLUTIONS IN THE MAGNETOHYDRODYNAMIC CURRENTS IN THE HYPERSONIC APPROXIMATION. Pleshanov, A. S. (Power Engineering Inst., Moscow). Dokl. Akad. Nauk SSSR, 180: 813-16(June 1, 1968). (In Russian).

A general solution was derived for the Cauchy problem involving spatial nonstationary and stationary currents of an anisotropically conducting, nonviscous gas in a magnetic field, in the absence of an electric field at Mach numbers $M \gg 1$. It was assumed that the pressure gradient in the equation of motion may be neglected. Use of the hypersonic approximation simplifies the calculations allowing derivation of a generalized solution for the plane stationary case which may be extended to other coordinate systems—cylindrical, spheric, and other ones. In the absence of a magnetic field, the solution permits disturbances; application of a field evens out the original distribution, broadening the conditions which do not result in disturbances. Under certain conditions, similar general solutions may be obtained when an electric field is applied. (TTT)

50077 MAGNETOHYDRODYNAMICS. Heywood, J. B. (Central Electricity Research Labs., Leatherhead, Eng.). Phys. Educ., 3: 260-5 (Sept, 1968).

The phenomena which characterize an MHD flow are explored, and it is shown that two effects dominate. The first is how the flow distorts the magnetic field; the other is how the magnetic forces can change the nature of the flow. (auth) (UK)

50078 SOME ELECTRICALLY DRIVEN FLOWS IN MAGNETOHYDRODYNAMICS. PART 2. THEORY AND EXPERIMENT. Hunt, J. C. R. (Central Electricity Research Labs., Leatherhead, Eng.); Malcolm, D. G. J. Fluid Mech., 33: 775-801 (Sept, 23, 1968).

The theory of Part 1 (Hunt and Williams (1968)) is extended to analyze the distribution of velocity and electric current in an electrically conducting liquid between two circular electrodes of finite diameter, when a current is passed between them. The electrodes are set opposite to each other in insulating planes and a magnetic field is applied perpendicular to these planes. When the Hartmann number $M \gg 1$ it is found that the current is confined to the cylinder of fluid joining the electrodes. This effect is accounted for by the velocity which is induced in thin layers of thickness $O(M^{-\frac{1}{2}})$ at the circumference of the cylinder. Amongst other results, it is found that in the limit $M \to \infty$ the resistance of the fluid between the electrodes becomes that of the cylinder of fluid joining the electrodes. Some experiments are described to test the validity of this theory. Measurements were made, as a function of the magnetic field, of (a) the potential difference between the copper electrodes, the fluid being mercury, (b) the electric potential distribution in the fluid between the disks and in the thin layers between the electrode edges, by means of an electric potential probe, and (c) the velocities induced in the layers using a Pitot tube. Conclusions were: (i) the overall predictions of the theory are correct; (ii) the results of the two probe experiments approximately correlated with each other, despite the theory still having some limitations and the behaviour of these probes still being somewhat uncertain. (auth) (UK)

50079 THREE-DIMENSIONAL MHD DUCT FLOWS WITH STRONG TRANSVERSE MAGNETIC FIELDS. PART I. OBSTACLES IN A CONSTANT AREA CHANNEL. Hunt, J. C. R.; Ludford, G. S. S. (Cornell Univ., Ithaca, N. Y.). J. Fluid Mech., 33: 693-714 (Sept, 23, 1968).

An analysis is given of incompressible three-dimensional flows of electrically conducting fluids under the action of transverse magnetic fields which are assumed to be sufficiently strong that the interaction parameter $N (= M^2/R) \gg 1$, where M is the Hartmann number and R is the Reynolds number. It is assumed that $R \gg 1$ and R_m (magnetic Reynolds number) $\ll 1$, so that experimental verification of the theory may be possible. The main results are: (i) when a thick body is placed in a parallel-sided channel with non-conducting walls the flow over it is highly dependent on the conductivity of the body, in a surprising way. If the body is non-conducting, there is no flow within that cylinder which circumscribes the body and is parallel to the magnetic field; outside the cylinder the flow is plane and potential and enters or leaves the surface shear layer of this cylinder at right angles. If the body is conducting flow over it is possible and is of a different nature outside and inside the cylinder. (ii) When a non-conducting flat plate is placed in such a channel no blocking of the flow occurs. If the plate is elongated in the flow direction, the flow over it becomes identical to that calculated by Hasimoto (1960) and, if elongated at right angles to the flow, becomes identical to that calculated by Dix (1963). Of particular interest in the analysis are the two types of layer which occur in these flows, the first being the Hartmann boundary layer, which is shown to have a controlling influence on the vorticity of the core flow in three-dimensional situations analogous to that of the Eckman layer in rotating-fluid flows. The second type, the free shear layer at the circumscribing cylinder, is of interest because of its internal structure and effect on the external flow. (auth) (UK)

50080 LAMINAR HYDROMAGNETIC FLOW IN A RECTANGULAR CHANNEL WITH POROUS WALLS OF DIFFERENT PERMEABILITY. Reddy, P. G. Arch. Mech. Stosow., 19: 385-97 (1967).

A generalization is presented of work of Terrill and Shrestha to include effects of magnetic drag due to imposed magnetic field perpendicular to parallel porous walls. Other walls of channel are infinitely remote. Because normal wall velocities are unequal, there is also streamwise variation. (App. Mech. Rev.)

50081 OSCILLATIONS OF A CONDUCTING GAS ACTED ON BY A PERIODIC ELECTROMAGNETIC FIELD. Zaklyaz'minskii, L. A.; Cherepanov, A. N. Zh. Prikl. Mekh. Tekh. Fiz., No. 3, 81-5 (May-June 1968). (In Russian).

Gas from a source moves along the x axis. At a distance $x = \pm 1$ are planar current surfaces in which the current goes along the y axis. The magnetic field created by the current is directed along the z axis, and is augmented by a constant magnetic field H_0. Equations describing the motion of the gas, the distribution of magnetic field in the medium and the current in the external electric circuit are presented in dimensionless form. A periodic solution of this set of equations is sought under the condition that the external emf E_1 is a periodic function of the time τ. The solution is obtained in series form. The oscillations in parameters of the system are not sinusoidal, even though the external force causing the oscillations is sinusoidal in form. (TTT)

50082 INTEGRAL REPRESENTATION FOR CERTAIN LINEARIZED MAGNETOHYDRODYNAMIC FLOWS IN THE PLANE. Hector, David L. (Univ. of Denver). Z. Angew. Math. Phys., 19: 587-600 (July 25, 1968).

The extension of an integral equation formulation to include linearized MHD flows in two dimensions is explored. A representation of the velocity, pressure, and magnetic fields developed by Clauser is employed. The fundamental idea is to distribute solutions of two-dimensional flows in a way that allows one to build up a solution for flow past a body. Only convex bodies smooth enough to admit the construction of a local normal coordinate system at each point on the body surface are considered. (M.H.R.)

Geophysics

Refer also to abstract 50065.

50083 (N-68-11826) THE ARTIFICIAL ELECTRON BELT, OCTOBER 1963 TO OCTOBER 1966. Beall, D. S. (Johns Hopkins Univ., Silver Spring, Md. Applied Physics Lab.). July 14, 1967. 16p. (NASA-CR-90542). CFSTI.

Satellite 1963 38C, launched September 28, 1963 into a polar orbit at 1100 km, continues to operate normally as of July 1967. The measured decay of the Starfish electron radiation belt is discussed for over a 36-month period commencing 15 months after the Starfish high-altitude nuclear detonation of July 9, 1962. The main results of a 27-month study are summarized and the time coverage is extended to a full 3 years. The latest data collection interval occurred in October 1966. A table lists all the intervals for which data are presented. (auth) (STAR)

50084 POLAR ELECTROJET. Seiler, Eberhard; Kertz, Walter (Technische Hochschule, Brunswick). Z. Geophys., 33: 371-402 (Dec. 1967). (In German).

The polar electrojet is the concentrated part of the polar magnetic substorm on the night side of the auroral zone. Model current systems for this phenomenon are described. The temporal and spatial development of a polar magnetic substorm is very similar to that of an auroral substorm. This indicates the same origin for both phenomena, that is, a periodically strongly enhanced precipitation of particles in the auroral zone. Contours of constant flux of trapped electrons with energies > 40 keV are illustrated as a function of geomagnetic latitude and local time; bremsstrahlung measurements on these have been made by balloon experiments. Correlations between the phenomena were made by triangulation; variations in x-ray intensity are caused by variations in conductivity, not by the electric field. Some disturbances involving x-ray eruptions without local magnetic activity have been observed, but magnetic activity is always accompanied by x-ray eruption. Other direct and indirect observations of such events are described. Theoretical explanations are reviewed. (BBB)

50085 RETARDED IONOSPHERIC D-REGION EFFECTS IN SHORT-WAVE FIELD STRENGTH REGISTRATIONS CAUSED BY NUCLEAR EXPLOSIONS. Nitzsche, P. (Deutsche Akademie der Wissenschaften zu Berlin, Neustrelitz, Ger.). Z. Meteorol., 18: 449-51 (1966). (In German).

Effects, presumably of the Soviet nuclear tests on 22 and 28 October 1962, were detected as strong disturbances in absorption at the Norddeich–Neustrelitz measuring zone on 22, 28, 29, and 30 October 1962. The pen registrations are illustrated and

compared with mean daily values of D region absorption; they are very probably not associated with solar phenomena, nor are they a manifestation of the winter anomaly. Nuclear tests near Semipalatinsk and Novaya Zemlya were conducted during this period, and the nature of the registrations indicates a similar origin for all 4. The last 2 are suggested to be afterdisturbances. The delays for the dates when the tests actually occurred were 260 min and 150 min. Without further information about the tests a mechanism can be only speculative; it is suggested that a MHD disturbance resulting from the tests caused a sinking of the mirror point for captured particles, producing a partial leakage of the outer radiation belt. (BBB)

50086 EXPLORATION OF THE LOWER IONOSPHERE. Rawer, Karl. Bild Wiss., 5: 486-95(June 1968). (In German).

Investigations of the ionosphere are described, beginning with its discovery. The D, E, and F layers are defined. The plasma state of this region is described, with attention to electron density and conductivity. Problems of data collection and of variation in the state of the plasma with time are described. Radio measurements used for determination of electron density allow the preparation of ionograms, or electron density profiles, for determining positions of various layers; experiments to determine electron density in these layers are described and critical wavelength experiments illustrated, with an explanation of Fejer's method and the Luxemburg–Gorkii effect. Information gained from rocket experiments is outlined. The functioning of international organizations and ESSA is described in noting plans and directions for the future. (BBB)

50087 OBSERVATION AND INTERPRETATION OF THE $O_2(^1\Delta_g - {}^3\Sigma_g^-)$ AIRGLOW EMISSIONS. Gattinger, R. L. (National Research Council of Canada, Ottawa). Can. J. Phys., 46: 1613-26(July 15, 1968).

The $O_2(^1\Delta_g - {}^3\Sigma_g^-)$ 0,1 band at a wavelength of 1.58 μ has been observed with a scanning Fabry–Perot system in the evening twilight airglow at 45.2°N. The decay time constant at a solar depression angle of 10° was about 45 minutes during the winter and about 30 minutes during the summer. The brightness at a solar depression angle of 6° was about 25 kR for both seasons. The emission could not be detected in the morning twilight. Theoretical solutions were obtained for an oxygen–hydrogen atmosphere to explain the observed behavior of the emission, with the assumption that excitation of the $O_2(^1\Delta_g)$ state is mainly due to photodissociation of ozone in the Hartley continuum. The results indicate that the ozone dissociation mechanism is probably the correct one. Formation of the $O_2(^1\Delta_g)$ state by three-body recombination of atomic oxygen has also been included to explain the observed emission of the $O_2(^1\Delta_g - {}^3\Sigma_g^-)$ 0,0 band at a wavelength of 1.27 μ in the night airglow. The evening twilight seasonal brightness variations of the 1.27 μ and 1.58 μ bands observed with ground-based instruments have not been satisfactorily explained. (auth)

50088 ON THE DEPENDENCE OF THE APPEARANCE OF THE IONOSPHERIC LAYER E2 UPON SOLAR ACTIVITY. Serafimov, K. B. (Inst. of Geophysics, Sofia). Compt. Rend. Acad. Bulg. Sci., 21: 331-4(1968).

An analysis of data was made for Sofia (ϕ = 42° 41'N; λ = 23° 21'E) over the period 1960 through 1966. (M.O.W.)

50089 ON THE THEORY OF THE IONOSPHERIC F LAYER. Tuan, T. F. (Northeastern Univ., Boston). J. Phys., B (London), 1: 966-72(Sept. 1968).

An analytic solution to the time-dependent diffusion equation for the F layer was constructed through perturbation theory. The solution is expressed in terms of arbitrary scale-height factor. A closed-form expression for the decay constant in terms of the recombination rate coefficient and the scale-height factor was also derived. The results for a scale height of 80 km and scale-height factor 1.4 were compared with the experimental results of Wright and Fine (1959) at different hours after sunset when production processes are negligible. (auth) (UK)

50090 INTENSITY AND ROTATIONAL TEMPERATURE VARIATIONS OF HYDROXYL EMISSION IN THE NIGHT GLOW. Shefov, N. N. (Inst. of Physics of Atmosphere, Moscow). Nature (London), 218: 1238-9(June 29, 1968).

It had been noted that there are indications of variations of the intensity and rotational temperature of OH emission with increasing geomagnetic activity, but in the analyses of some geomagnetic storms this effect was strongly masked by ordinary variations of the emission with time. In order to avoid this masking a method excluding seasonal and solar cycle variation is described. It was evident that variations of intensity and rotational temperature continue for a few days after commencement of a geomagnetic storm. Values for the additional energy release of the hydroxyl emission appearing after storm commencement were obtained. The amplitude of the first maximum of ΔI decreases toward equatorial regions, while the additional energy release ΔE becomes zero at latitudes less than about 30 to 40°. The average OH emission intensity at latitudes near 60°N is approximately three times that at latitudes near 30 to 40°N. It is noted that at more southern stations the effect of geomagnetic storms is seen a few days later than in high latitude regions, and the lag increases monotonically toward the equator. (UK)

50091 LABORATORY EXPERIMENTS WITH PLASMA FLOW PAST UNMAGNETIZED OBSTACLES. Fahleson, U. Planet. Space Sci., 15: 1489-97(Oct. 1967).

A brief discussion of data obtained from wind tunnel experiments, satellites, and rockets is presented. The model scaling problems encountered when trying to simulate the flow of a plasma past bodies in space using a plasma wind tunnel is reviewed. A couple of experiments are described that may simulate a satellite in the solar wind and Moon–solar wind interactions, which place two strong requirements on the plasma heater. It must operate at a temperature of 10^5 to 10^6°K and should use air as a gas. This is not probable with the present state of arc heater technology. Simulating a rocket shot into the aurora appears to be feasible with present-day equipment. (App. Mech. Rev.)

Low-Temperature Physics

Refer also to abstracts 50486 and 50492.

50092 (BNL–12842) OBSERVATIONS OF FLUX JUMP BEHAVIOR RELATED TO VARIOUS CHANGES OF GEOMETRY, AND THERMAL AND ELECTRICAL ENVIRONMENT. McInturff, A. D. (Brookhaven National Lab., Upton, N. Y.). [1967]. 10p. (CONF-680621-9). Dep. CFSTI.

From Conference on Superconducting Devices and Accelerators, Upton, N. Y.

Hysteresis curves were plotted for superconducting magnets with various geometries and in various thermal and electrical environments. These curves yielded information on flux jump behavior due to changes in geometry, or in thermal and electrical environment. (J.W.R.)

50093 (JINR–P13-4014) METHOD OF PRODUCING SUPER-LOW-TEMPERATURES BY DILUTING ^{3}He IN ^{4}He. Neganov, B. S. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems). 1968. 42p. (In Russian). Dep.

A short description is presented of the principle of operation of refrigeration devices based on the use of latent heat in diluting liquid ^{3}He in ^{4}He and the quantitative analysis is made. In particular, the Joule–Thompson effect in a solution has been considered. It has been stated that, practically, the effect is a result of heating due to friction and the corresponding formulas for calculations have been given. It has been found that dilution specific heat capacity at constant osmotic pressure coincides with the specific heat capacity at a constant volume at any temperatures below 0.1°K and taking this into account the refrigeration capacity of the system has been calculated and heat calculations of heat exchangers have been made for cooling the inverse flow ^{3}He in the continuous operating devices. A new type of continuously operating heat exchanger has been suggested and the advantage of its application for cooling the ^{3}He flow. The formula has been obtained for calculating the heat flow through heat bridges with the account of heat transfer due to ^{3}He diffusion. (auth)

50094 (LA-DC–9731) MISCELLANEOUS OBSERVATIONS ON FILM FLOW. Campbell, L. J.; Hammel, E. F.; Jones, D. M.; Keller, W. E. (Los Alamos Scientific Lab., N. Mex.). [1967]. 7p. (CONF-680808–4). Dep. CFSTI.

From Conference on Low Temperature Physics, St. Andrews, Scotland.

Simple level-sensing devices, previously shown to be useful for probing the relative chemical potential in the flowing He(II) film, were used to investigate several aspects of dissipation in the film when flow is initiated by either gravitational or thermal gradients. (M.H.R.)

50095 (UCRL–18319) THE THERMODYNAMIC PROPERTIES OF ^{4}He NEAR THE MELTING LINE. Hoffer, James Karl (California Univ., Berkeley. Lawrence Radiation Lab.). July 1968. Contract W-7405-eng-48. 231p. Dep. CFSTI.

Thesis.

Constant volume heat capacity measurements have been made on ^{4}He covering the entire volume range of the bcc solid phase and the high-volume portion of the hcp phase. The C_v measurements extend to low-enough temperatures to determine the entropy accurately and the direct volume measurements were sufficiently precise to establish the V–T phase diagram. The entropy–volume

relations in the various two-phase mixtures were then used to calculate the P–T phase diagram. The hcp–bcc solid–solid transition was found to have a more regular behavior than previous direct PVT data would suggest. Combined with data recently obtained in this laboratory on the superfluid liquid phase the low-temperature P–T and V–T melting lines were accurately determined, yielding quantitatively the minimum in the P–T curve at 0.776°K and the maxima in the V–T freezing and melting curves at 0.801 and 0.886°K, respectively. No linear term in the heat capacity of the hcp phase was observed, and the data yielded a temperature-independent Grüneisen parameter of 2.80 ± 0.05 except within 0.02°K of the transition temperatures where a small anomaly was observed. The bcc data were sufficiently extensive to determine the thermodynamic properties qualitatively throughout the phase. The volume dependence of the heat capacity was found to be normal, yielding values of 3.0 ± 0.5 for the Grüneisen parameter, except within 0.02°K of melting, where an anomaly similar to but larger than that in the hcp phase was observed. (auth)

50096 SUPERCONDUCTIVITY OF THE PHASE $CeCo_2$ AT ZERO AND HIGH PRESSURE. Luo, H. L. (Univ. of California, San Diego, La Jolla); Maple, M. B.; Harris, I. R.; Smith, T. F. Phys. Lett., 27A: 519-20(Sept. 9, 1968).

The superconducting transition temperatures of a number of alloys in the homogeneity range about the composition $CeCo_2$ have been measured and were observed to be practically pressure-independent. (auth)

50097 STABILITY OF ZERO-FREQUENCY CURRENTS IN SIMPLE CONNECTED SUPERCONDUCTORS. Fulton, T. A. (Bell Telephone Labs., Inc., Murray Hill, N. J.). Phys. Lett., 27A: 521-2(Sept. 9, 1968).

Measurements are reported which reduce by several orders of magnitude the experimental upper bounds on the resistivity of simply connected superconductors. (auth)

50098 SECOND CRITICAL VELOCITY OF LIQUID HELIUM IN A NARROW ANNULUS. Jinchvelashvili, B. G.; Kiknadze, L. V.; Mamaladze, Yu. G.; Tsakadze, J. S. (Inst. of Physics, Tbilissi, USSR. Inst. of Theoretical Physics, Moscow). Phys. Lett., 27A: 524-5(Sept. 9, 1968).

The temperature dependence of the second critical velocity of liquid helium above which ρ_s becomes equal to zero is discussed. It is stated that the realization of a nonequilibrium regime of motion causes an ambiguity in the experimental results observed in measurements of the λ-point shift made both in a rotated annulus and in a turbulent heat flow. (auth)

50099 RESISTANCE JUMP IN A SUPERCONDUCTING CYLINDER WITH CURRENT AND THE PHENOMENOLOGICAL INTERPRETATION OF THE MEISSNER EFFECT. Freud, R. Phys. Lett., 27A: 503-4(Sept. 9, 1968).

It is shown that when modifying London's theory by assuming the external magnetic field not to penetrate into the superconducting phase, the theory leads to a resistance jump of $\frac{3}{2}$ R_n, instead of $\frac{1}{2}$ R_n, in agreement with experiment. (auth)

50100 TWO CRITICAL VELOCITIES IN SUPERFLUID HELIUM? Luban, M.; Miller, S. (Bar-Ilan Univ., Ramat-Gan, Israel). Phys. Lett., 27A: 501-2(Sept. 9, 1968).

It is shown that Amit's proposed thermodynamic potential for superfluid helium implies the existence of two observable critical velocities. Specific experimental tests of this prediction are proposed. (auth)

50101 ANOMALOUS VALUES OF THE UPPER CRITICAL FIELD IN SUPERCONDUCTING INDIUM ALLOYS. Thomas, E. J. (Univ., Manchester, Eng.). Phys. Lett., 27A: 495-6 (Sept. 9, 1968).

High values of the upper critical field are reported for unpolished indium–lead and indium–thallium alloys. The results are explained by a recent theory of Shmidt if a high lattice-imperfection density exists at the surfaces of the sample. (auth)

50102 IS ABRIKOSOV'S STRUCTURE STABLE? Maki, K. (Institut Max von Laue, Garching, Ger.). Phys. Lett., 27A: 481-2(Sept. 9, 1968).

Making use of the time-dependent Ginzburg–Landau equation, the excitation spectrum of the fluctuation in the order parameter in a Type-II superconductor is studied. It is shown that the two-dimensional regular array of vortices is always unstable at least in an infinite medium. (auth)

50103 FLUX FLOW RESISTANCE AND $\kappa_2(T)$ PARAMETER FOR TYPE-II SUPERCONDUCTING VANADIUM. Usui, N.; Ogasawara, T.; Yasukochi, K. (Nihon Univ., Tokyo). Phys. Lett., 27A: 529-30(Sept. 9, 1968).

A relation between flux flow resistivity and $\kappa_2(T)$ recently presented by Caroli and Maki was experimentally investigated in an intrinsic Type-II superconductor, vanadium. (auth)

50104 CRITICAL HEAT FLUX IN LIQUID HELIUM II IN THE NEIGHBORHOOD OF THE λ TRANSITION. Bhagat, S. M.; Winer, B. M. (Univ. of Maryland, College Park). Phys. Lett., 27A: 537-8(Sept. 9, 1968).

The heat flux required to produce a bubble at a wire submerged in liquid helium II at temperatures close to the λ transition was measured. (auth)

50105 BOUND EXCITATIONS OF A SINGLE VORTEX IN A PURE TYPE-II SUPERCONDUCTOR. Hansen, E. Brun (Univ., Copenhagen). Phys. Lett., 27A: 576-7(Sept. 9, 1968).

The spacing between adjacent branches in the excitation spectrum is found to increase with $\hbar\omega_L$ when magnetic effects are taken into account. Due to Zeeman splitting of the bogolon levels the energy gap Δ_0^2/E_F will in some cases disappear. (auth)

50106 ULTRASONIC ATTENUATION MEASUREMENTS IN NORMAL AND SUPERCONDUCTING ZINC. Lea, M. J.; Dobbs, E. R. (Univ. of Lancaster, Eng.). Phys. Lett., 27A: 556-7 (Sept. 9, 1968).

Measurements of the anisotropy of the electronic attenuation of longitudinal ultrasound, the electronic mean free path and the superconducting energy gap in zinc are presented. (auth)

50107 MAGNETIZATION OF A HOLLOW SUPERCONDUCTING TUBE IN THE SHEATH STATE. Thomas, E. J. (Univ. of Manchester, Eng.). Phys. Lett., 27A: 565-6(Sept. 9, 1968).

It is shown that the magnetization characteristic of a hollow superconductivity tube containing trapped flux in the sheath state should contain a peak in increasing field. Experimental results are given to confirm this prediction. (auth)

50108 MACROSCOPIC QUANTUM EFFECTS IN SUPERFLUIDS. Vinen, W. F. (Univ. of Birmingham, Eng.). Rep. Progr. Phys., 31: 61-121(1968).

A general account of macroscopic quantum effects in superfluid systems is given, covering both superfluid helium and superconductors. An elementary theory of superflow is first developed, based on the idea of the condensate wave function, this function being introduced as an essentially phenomenological concept. It is shown how this theory leads to the prediction of the quantization of circulation, of the quantization of flux and of related effects, and how it contains the idea, originally proposed by F. London (1950 and 1954), that a superfluid system exhibits long-range order in the momentum vector. The experimental evidence that the theory is correct is reviewed, and the link with microscopic theory is made. (auth) (UK)

50109 ^{4}He VISCOSITY IN THE RANGE OF 14 TO 31°K AND AT A PRESSURE UP TO 100 atm. Rudenko, N. S.; Karnus, A. I. (Inst. of Physics and Tech., Kharkov). Ukr. Fiz. Zh., 13: 1333-7(Aug. 1968). (In Russian).

The experimental viscosity data of ^{4}He were measured in the range of 14° and 31°K and at pressure to 100 atm. The data obtained are not in agreement with Enskog's semi-empirical expressions for the viscosity founded on the basis of his theory of pressure gases of hard spheres. The law of corresponding states for the ^{4}He viscosity factor in this interval of temperatures and pressures is shown to be not applicable. (auth)

50110 EFFECT OF FLUCTUATIONS ON THE PROPERTIES OF A SUPERCONDUCTOR ABOVE THE CRITICAL TEMPERATURE. Aslamazov, L. G.; Larkin, A. I. (Inst. for Theoretical Physics, Moscow). Sov. Phys.-Solid State (Engl. Transl.), 10: 875-80(Oct. 1968).

Translated from Fiz. Tverd. Tela, 10: 1104-11(Apr. 1968).

It is shown that as the critical temperature is approached, the conductivity of a metal in the normal state and the sound absorption coefficient are enhanced because of fluctuations in the system. The effect increases in samples which are in the form of films and crystal whiskers. (auth)

50111 SURFACE IMPEDANCE OF NIOBIUM NEAR H_{c2}. Hibler III, W. D.; Maxfield, B. W. (Cornell Univ., Ithaca, N. Y.). Contract AT(30-1)-2150. Phys. Rev. Lett., 21: 742-5(Sept. 9, 1968). (NYO-2150-45).

The magnetic field and angular dependence of the surface impedance of superconducting niobium near H_{c2} is measured and compared with predictions based on the theory of Caroli and Maki. (auth)

50112 THEORY OF QUANTIZED VORTICES. Chester, G. V.; Metz, R.; Reatto, L. (Cornell Univ., Ithaca, N. Y.). Phys. Rev., 175: 275-85(Nov. 5, 1968).

Model many-body wave functions are constructed for a quantized vortex line and ring. The corresponding variational energies are calculated using an approximate integral equation derived by Per-

cus and Yevick for classical fluids. The energy of the line is close to that found in the Hartree theory. However, the density distribution in the core region is markedly different, and the core size is somewhat smaller, being of the order of 1 Å. The velocity of translation of the vortex ring is calculated by a new method, and excellent agreement is obtained with the experimental results of Rayfield and Reif. The condensed-state wave function is computed numerically, and it is found that in the core of the vortex there are about 20% fewer particles in the condensed state than in the zero-momentum state when the sytem is in equilibrium. (auth)

50113 INVESTIGATION OF A NEW KIND OF ENERGETIC NEUTRAL EXCITATION IN SUPERFLUID HELIUM. Surko, C. M.; Reif, F. (Univ. of California, Berkeley). Phys. Rev., 175: 229-41(Nov. 5, 1968).

Evidence is presented for the existence of a new kind of neutral excitation generated in superfluid helium in the presence of a ^{210}Po α-particle source. The flux of neutral excitations is negligibly small above 0.6°K and increases as the temperature is decreased. The neutral excitations travel in the liquid at low temperatures through distances greater than 1 cm without appreciable scattering or attenuation. They produce He_2^+ ions and electrons at the free surface of the liquid, and positive ions and electrons at a suitably arranged metal plate immersed in the liquid. Experiments indicate that these neutral excitations are not photons. A possible model for the neutral is some kind of exciton. In addition, evidence is also presented that, at temperatures below 1°K, electrons within superfluid helium may emerge from the liquid into the vapor above its surface when they arrive at the liquid surface trapped in vortex rings. No such behavior is observed for positive ions. (auth)

50114 SOLUTION OF BOLTZMANN EQUATION FOR DEGENERATE FERMI SYSTEMS. Emery, V. J. (Brookhaven National Lab., Upton, N. Y.). Phys. Rev., 175: 251-6(Nov. 5, 1968).

A new method of solving the Boltzmann equation for a degenerate Fermi system is described and compared with the approximation of Abrikosov and Khalatnikov and with variational calculations. The first two terms in the expansions of the inverse relaxation times in powers of the absolute temperature are calculated, and the resulting expressions are applied to dilute mixtures of ^{3}He in liquid ^{4}He and to nearly ferromagnetic Fermi liquids. (auth)

50115 CRITICAL FIELDS OF THIN SUPERCONDUCTING FILMS. Mikheeva, M. N.; Shapoval, E. A. (Moscow State Univ.). Zh. Eksp. Teor. Fiz., 55: 1059-65(1968). (In Russian).

The dependence of the critical field strength on thickness of a film was investigated in detail for a case that is intermediate with respect to those previously studied, viz., when the film thickness is of the order of the electron mean free volume path. Comparison of the results with the experiments yields the BCS correlation parameter and the volume mean free path. The results are also compared with published experimental data on critical fields of thin tin, indium, or mercury films. (auth)

50116 VARIATIONAL QUANTIZED VORTEX FLOWS IN LIQUID HELIUM. Metz, Roger Nathan. Ithaca, N. Y., Cornell Univ., 1968. 146p.

Thesis.

In the last fifteen years the experiments of Hall and Vinen and Rayfield and Reif have demonstrated the existence of macroscopic flow excitations in liquid helium below the lambda point, whose circulations are quantized in units of h/M. Theoretical descriptions of these phenomena at absolute zero have generally been formulated within the context of imperfect Bose gas theory, and therefore are deficient with respect to their treatment of the system binding and the underlying correlations in the background superfluid. This paper gives a variational calculation of the energy of a vortex line, starting from an excited state trial wave function which contains a model of the core and a proper description of the fluid at large distances. The one-particle distribution functions which naturally arise in the energy functional are calculated numerically from Percus–Yevick and convolution-hypernetted chain-type integral equations in analogy with the classical analysis. The calculations are done for three special classes of trial functions and the lowest energy and its accompanying density profile determined. These results are then applied to the vortex-ring geometry in a large-ring approximation. To accomplish this, translational velocities are obtained from the usual "impulse" group velocity formula and from a new formula deduced from an analysis of the time-dependent density field. Theoretical calculations using the minimum line energy and this new velocity formula are shown to give better agreement with the Rayfield–Reif data than that obtained using the "impulse" velocity formula. The question of Bose–Einstein condensation is discussed in the context of a Jastrow approximation to the ground-state wave function, which allows a factorization of the single-particle density matrix at large distances. The shape of the "macroscopically occupied" state function is obtained and a discussion of the additional density of condensed particles due to the presence of vortex is given. (Disser. Abstr.)

50117 GROUND STATE OF LIQUID ^{4}He IN A MODEL OF SEMIFREE GAS. Ljolje, K. (Univ. of Sarajevo, Yugoslovia). Fizika (Zagreb), 1: 11-16(July 1, 1968).

The expectation value of the Hamiltonian of the system of ^{4}He atoms is evaluated for the wave function that is the product of two-body asymptotic wave functions at small interatomic distances for each pair of particles. The corresponding integrals are performed in a similar way as in the case of hard spheres of low densities. (auth)

50118 ISOTOPE EFFECT OF SUPERCONDUCTING α–URANIUM. Capellmann, H.; Schrieffer, J. R. (Univ. of Pennsylvania, Philadelphia). Phys. Rev. Lett., 21: 1060-1(Oct. 7, 1968).

Calculations show that the large, positive, isotope effect in α–uranium does not necessarily establish the existence of a new coupling mechanism to produce superconductivity. (auth)

50119 DEPENDENCE OF THE CRITICAL TEMPERATURE AND ENERGY GAP OF SUPERCONDUCTING ALUMINUM FILMS ON THEIR THICKNESS. Chubov, P. N.; Eremenko, V. V.; Pilipenko, Yu. A. (Physical-Technical Inst. of Low Temperatures, Kharkov). Zh. Eksp. Teor. Fiz., 55: 752-65(1968). (In Russian).

The dependences of the critical temperature T_c and of the limiting energy gap $2\Delta_0$ on thickness d are found to be the same for aluminum films deposited on glass or quartz in vacuum at 293°K. For thicknesses between 2000 and 40 Å the relative increase of the critical temperature $\Delta T/T_c$ is proportional to 1/d. The deformational increase of the critical temperature ($\Delta T_c < 0.1$°K) due to the difference of the thermal expansion coefficients of aluminum and the backing material is independent of the thickness. The much greater increase of T_c for thin films is ascribed to the finite size of the sample along one or more dimensions. (auth)

50120 INVESTIGATION OF DISSIPATIVE PROCESSES IN MIXED-STATE SUPERCONDUCTORS LOCATED IN THE FIELD OF REACTOR IRRADIATION. Andronikashvili, E. L.; Ashimov, S. M.; Tsakadze, Dzh. S.; Chigvinadze, Dzh. G. (Inst. of Physics, Erevan). Zh. Eksp. Teor. Fiz., 55: 775-80(1968). (In Russian).

Dissipative processes in superconductors in the mixed state are investigated. The effect of reactor irradiation on the processes and also the change in the critical temperature T_c due to neutron irradiation at 4.2°K are also studied. (auth)

50121 THEORY OF TUNNELING IN ANISOTROPIC SUPERCONDUCTORS. Gorbonosov, A. E.; Kulik, I. O. (Physical-Technical Inst. of Low Temperatures, Kharkov). Zh. Eksp. Teor. Fiz., 55: 876-88(1968). (In Russian).

Some features of the volt–ampere curves of the tunnel current in anisotropic superconductors are investigated. Two groups of characteristic features can be discerned: (1) those connected with the extreme values of the gap on the Fermi surface (minima, maxima, and saddle points); (2) those related to the extreme values of Δ (minimum or maximum) on the lines of the Fermi surface $v\nu = 0$ where ν is the direction of the normal to the junction surface. Singularities of the first kind occur in single crystals and polycrystalline substances (with crystallite dimensions $\gg \xi_0$). Singularities of the second kind ("boundary singularities") are manifest only in single crystals; in this case the singularity amplitude may be appreciable for diffuse scattering of the electrons on the tunnel contact surface or if the barriers are very thin. The analysis is valid for Fermi surfaces of arbitrary shape and for arbitrary anisotropy of the gap. (auth)

50122 EFFECT OF ELECTRON–PHONON INTERACTION ON THE HIGH-FREQUENCY PROPERTIES OF SUPERCONDUCTORS. Lazarenko, Yu. P. (Ioffe Inst. of Physics and Tech., Leningrad). Zh. Eksp. Teor. Fiz., 55: 1056-8(1968). (In Russian).

It is shown that the mechanism suggested by Shin cannot explain pre-threshold absorption of infrared rays in superconductors. (auth)

50123 ON THE CRITICAL FIELD OF SURFACE SUPERCONDUCTIVITY AND THE STRUCTURE OF A SUPERCONDUCTING SURFACE LAYER IN AN INCLINED FIELD. Kulik, I. O. (Moscow Engineering-Physics Inst.). Zh. Eksp. Teor. Fiz., 55: 889-903(1968). (In Russian).

Two problems are considered. (1) The problem of calculating the critical field of surface superconductivity H_{c3} for pure superconductors is solved within the framework of the microscopic

superconductivity theory. It is shown that the ratio H_{c3}/H_{c2} for $T = 0$ is ≥ 1.99 for a specular law of reflection of the electrons at the metal surface and ≥ 2.09 for diffuse reflection (the numerical calculation was performed by a variational method). (2) The structure of a superconducting surface layer in an inclined magnetic field is investigated in the region of applicability of the Ginzburg–Landau equations ($T \to T_c$). It is shown that for an angle of inclination $\theta \neq 0$ the surface superconducting layer possesses a vortex structure which is similar to the Abrikosov vortex lattice. For small inclination angles the period of the structure $\alpha \sim \xi/\sqrt{\theta} \gg \xi(T)$ where $\xi(T)$ is the temperature-dependent coherence length. (auth)

50124 EXPERIMENTAL OBSERVATION OF DEPAIRING PHENOMENON IN SUPERCONDUCTING TIN FILMS. Bhatnagar, Anil Kumar (Univ. of Maryland, College Park); Stern, Edward A. Phys. Rev. Lett., 21: 1061-4(Oct. 7, 1968).

The gradual decrease to zero of supercurrent due to depairing in thin tin films has been observed as a function of external magnetic field in reasonable agreement with theory. (auth)

50125 DIFFERENT EFFECT OF CERIUM AND GADOLINIUM IMPURITIES ON THE PRESSURE DEPENDENCE OF THE SUPERCONDUCTING TRANSITION TEMPERATURE OF LANTHANUM. Coqblin, B.; Ratto, C. F. (Laboratoire de Physique des Solides, Orsay, France). Phys. Rev. Lett., 21: 1065-7(Oct. 7, 1968).

The different effect of cerium and gadolinium impurities on the pressure dependence of the superconducting transition temperature of lanthanum is due to different electronic structures of the rare-earth impurity. The ionic model explains the properties of gadolinium alloys, while the resonant scattering theory explains those of cerium alloys. (auth)

Plasma and Thermonuclear Physics

Refer also to abstract 50071.

50126 (EUR-CEA-FC-352) RAPPORT D'ACTIVITE DU GROUPE DE RECHERCHES POUR L'ANNEE 1965. (Report on the Activities of the Research Group, Annual, 1965). (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). [nd]. 277p. (In French). Dep.

MAGNETIC MIRROR MACHINES — plasma stabilization in, effects of gyration radii on

PLASMA — wave propagation in cylindrical, collisional effects on quasi-electrostatic, (T)

PLASMA — production by laser irradiation, heating and expansion properties in; kinetic equations for, research on

LITHIUM — hydrogen-ion (H_2^+) and (H_3^+) reactions with, dissociation cross sections for, (E)

MAGNETIC MIRROR MACHINES — plasma stability in Bille-en-Tete; plasma pulse heating in Bille-en-Tete; plasma confinement in DECA II, limitations of; plasma gun operation for DECA II, properties of

PLASMA ACCELERATORS — properties of coaxial, for DECA II device

PLASMA — diagnostics in theta-pinch Balloon experiment; electron beam interactions with, research on; wave scattering on cylindrical, electromagnetic, (E/T) (M.O.W.)

50127 (SU-IPR-255) BIBLIOGRAPHY OF STANFORD REPORTS, PAPERS AND CONFERENCE PRESENTATIONS ON PLASMA PHYSICS. (Stanford Univ., Calif. Inst. for Plasma Research). Revised July 1968. 42p.

A listing of 255 publications since formation of the Institute for Plasma Physics is presented. (M.O.W.)

50128 PLAZMA-CHETVERTOE SOSTOYANIE VESHCHESTVA. Izdanie 3. (Plasma: The Fourth State of Matter. Third Edition). Frank-Kamenetskii, D. A. Moscow, Atomizdat, 1968. 160p.

General aspects of plasma physics are reviewed, considering models of continuous conducting media (magnetohydrodynamics) and motion of charged particles and their collisions. Plasma oscillations, instabilities, pinch, confinement by magnetic fields, and acceleration are discussed and analyzed. (R.V.J.)

Confinement and Heating of Plasma

50129 (INR-913) RESEARCH ON PRODUCTION AND CONTAINMENT OF PLASMA IN A SPHERICAL MULTIPOLE MAGNETIC FIELD. II. EXPERIMENTAL SYSTEM "KAKTUS." Sadowski, Marek (Institute of Nuclear Research, Warsaw (Poland)). 1968. 33p. Dep.

A detailed description of the experimental "Kaktus" system and its operational parameters is presented. Also described are: the spherical experimental chamber, electromagnets creating a spherical multipole magnetic field, auxiliary electromagnets producing a mirror geometry field, and plasma injectors. A description of a vacuum system and current impulse generators, which supply fast gas valves and plasma injectors, is given. An earth system, a shielding arrangement and control systems are also described. The description includes only arrangements requiring additional tests. (auth)

50130 (IPP-2/70) ON THE EVALUATION OF THE WENDELSTEIN EXPERIMENTS. von Gierke, G.; Grieger, G.; von Hagenow, K. U. (Institut fuer Plasmaphysik, G.m.b.H., Garching (West Germany)). July 1968. 49p. Dep.

The earlier evaluations of the experiments performed in 1965 in the Wendelstein stellarator W Ib have been revised. In particular, later probe calibrations by Hashmi et al., the shape of the magnetic surfaces, and the magnitude of the rotational transform as obtained by means of a pulsed electron beam have been taken into account. The results are compared with numerical calculations based upon a simple model assuming resistive diffusion modified for stellarator geometry and recombination on the surfaces of the emitter and the probes. The time dependence of the temperature of the emitter and the elliptical shape of the cross sections of the magnetic surfaces are also considered. The measured peak ion densities and even their dependence on time agree fairly well with the calculations as long as ion inertia can be neglected. Equilibrium breaks down if the required velocity of the balancing mass flow (which is necessary for stellarator equilibrium) exceeds about the ion thermal velocity. In the transition region estimates taking into account the effect of ion inertia seem to show agreement with the observations. (auth)

50131 (LA-3863) CHARACTERISTICS OF THE SCYLLACITA θ-PINCH. Thomson, D. B.; Caird, R. S.; Ewing, K. J.; Finlayson, V. A.; Fowler, C. M.; Garn, W. B.; Kemp, E. L.; Kewish, R. W. Jr.; Sawyer, G. A.; Tuck, J. L. (Los Alamos Scientific Lab., N. Mex.). Apr. 1968. Contract W-7405-eng-36. 31p. Dep. CFSTI.

Scyllacita is a small high-voltage θ-pinch developed for application to experiments with explosive magnetic compression. Results of laboratory studies are given of the dependence of the first half-cycle neutron yield on pressure, reverse field, preionization, bank voltage, number of capacitors, and warmup. Best laboratory yields averaged 2×10^5 neutrons on first half cycle obtained at 60 to 100 microns deuterium with a bias of -1.4 kG. Reliability was sensitive to spark gap electrode spacings, which determine capacitor discharge simultaneity. A peak field of 55 kG, 12-μsec period, was obtained in an 8-cm-diameter coil, 24 cm long. A side-fed coil explosive implosion system was developed, which increased the initial Scyllacita field to about 250 kG in 5 μsec as the implosion progressed. Scyllacita was moved to the firing point, tested, and used with this implosion system for an explosive shot which gave a yield of about 5×10^3 neutrons. An upper limit to the enhancement due to explosive compression was 2×10^3 neutrons. The total time to achieve 250 kG, including the Scyllacita rise time, was 8 μsec. A large yield enhancement was not expected since the half life of laboratory produced plasmas in similar systems is typically about 3 μsec. These experiments helped show the importance of high E_θ, and resulted in the development of coil implosion systems having better axial magnetic symmetry. (auth)

50132 (MATT-648) VELOCITY-SPACE EFFECTS IN THE COMPUTER SIMULATION OF STELLARATOR CONFINEMENT. Smith, Craig G.; Bishop, A. S. (Princeton Univ., N. J. Plasma Physics Lab.). Sept. 1968. Contract AT(30-1)-1238. 8p. (CONF-680914-2). Dep. CFSTI.

From Plasma Simulation Conference, Los Alamos, N. Mex.

A pronounced microinstability has been observed in the course of a guiding-center simulation of axially symmetric toroidal confinement with the self-consistent electric field. The model and choice of values for the problem parameters follow those reported recently at Novosibirsk, with the sole exception that here the density is greater by a factor of ten. In this case, the electric field is larger, although the ratio of potential to kinetic energies remains at about 0.5%. The instability develops in a transient phase during which ions with large drift excursions are lost to the walls and the plasma seeks an equilibrium potential distribution. The evolution of the potential energy in the $m = 2$ azimuthal mode displays a high-frequency burst prior to decay to an equilibrium level. In the earlier stages, the electron distribution function is observed to have extremely well-defined gaps, independent of the magnetic moment, at parallel velocities 2.0 to 2.5 times thermal velocity. In time these are filled, but the velocity-space diffusion is preferentially effective for particles with small perpendicular energies, and holes at large values tend to persist. The imposed symmetry prohibits substantial cross-field diffusion by the turbulence. (auth)

50133 (NP-17625) WILLS PLASMA PHYSICS DEPARTMENT FIFTEENTH SIX-MONTHLY PROGRESS REPORT, 1ST JANUARY-30TH JUNE 1968. (Sydney Univ. (Australia). School of Physics). 9p. (PR-15). Dep.

A brief discussion of research work at Sydney is presented. (M.O.W.)

50134 RESEARCH ON THE ACCELERATION, THE REFLECTION, AND THE CONFINEMENT OF POSITIVE IONS BY COHERENT SPACE CHARGE FIELD GENERATED BY ENERGETIC ELECTRONS WITH QUASI-RELATIVISTIC PERPENDICULAR ENERGY. Consoli, T. Bull. Inform. Sci. Tech. (Paris), No. 128, 69-84(July 1968). (In French).

This brief survey is a qualitative description of an ensemble of studies of which the common aim is the quasi-total transfer of the energy of an electromagnetic field to an ionized medium by the use of electron cyclotron resonance excited in a nonhomogeneous static magnetic field. The energy of the electromagnetic field is directly coupled to the electrons and transferred to the ions through electrostatic space charge forces. The acceleration, reflection, or confinement of the ions depends upon the shape of the electrostatic and magnetic field distributions. (auth)

50135 TRANSPORT THEORY IN STRONG MAGNETIC FIELDS. Budd, H. F. (Groupe de Physique des Solides de l'Ecole Normale Superieure, Paris). Phys. Rev., 175: 241-51 (Nov. 5, 1968).

A unified treatment of transport phenomena in crossed electric and magnetic fields is presented. This theory is limited to strong magnetic fields, $\omega_c\bar{\tau} \gg 1$, where ω_c and $1/\bar{\tau}$ are the cyclotron and mean collision frequencies, respectively. It is not, however, limited to linear response in the electric field nor is a relaxation time approximation introduced. The semiclassical and quantum theories are developed along parallel lines. An irreversible transport equation is derived for the asymptotic state of the system, $\omega_c\tau \to \infty$, and it is shown that the asymptotic electron distribution is independent of the absolute values of the coupling constants to the scattering system, but dependent on the form of the scattering interaction. A perturbation theory in $1/\omega_c\bar{\tau}$ is performed and a generalized orbit-jump formula for the dissipative current is derived. Explicit expressions are derived for the ohmic case and are applied as an example to polar optical-phonon scattering. (auth)

50136 CONTAINMENT OF SINGLE PARTICLES IN STELLARATORS. Gibson, A.; Hugill, J.; Reid, G. W. (United Kingdom Atomic Energy Authority, Abingdon, Eng.). Phys. Rev. Lett., 21: 1052-5(Oct. 7, 1968).

Measurements of the containment of a distribution of single particles in a stellarator are described. Containment for more than 10^7 transits is observed for particles born outside the loss region of phase space. (auth)

Diagnostics of Plasma

50137 (NP-17620) HYDROGEN PLASMA DECAY MEASURED BY DOUBLE MICROWAVE INTERFEROMETER. Brand, G. F. (Sydney Univ. (Australia). School of Physics). June 1968. 8p. (ER-39). Dep.

A 120-Gc microwave interferometer was used in a double interferometer which can probe a region of plasma at two frequencies simultaneously (the other at 35 Gc). Peak electron densities from 10^{12} to 1.8×10^{14} cm^{-3} have been measured and compared with spectroscopic measurements. The interferometer is briefly described. (M.O.W.)

50138 MEASUREMENT OF THE SHIFT-TO-WIDTH RATIO AND SHIFT OF AN Ar II LINE AS FUNCTIONS OF ELECTRON TEMPERATURE AND DENSITY. Roberts, D. E.; Curzon, F. L. (Imperial Coll. of Science and Tech., London). J. Phys., B (London), 1: 973-6 (Sept. 1968).

Measurements are reported of the shift-to-width ratio and shift of an Ar II line emitted by a collision-dominated plasma as functions of electron density and temperature. The object of the experiment was to check the high-temperature régime of recently proposed formulas for the shift-to-width ratio. The plasma conditions were varied by employing a useful property of the Z-pinch source. The electron density of the plasma was obtained from the Stark width of the line studied, and the electron temperature from the ratio of the total intensity of this line to that of a nearby Ar III line. The results are in good agreement with theory. (auth) (UK)

50139 CONTRACTED HIGH-FREQUENCY DISCHARGES IN ARGON. Wagner, S. D.; Kagan, Yu. M.; Khrustalyov, G. Yu. Opt. Spectrosc. (USSR) (Engl. Transl.), 24: 360-2(May 1968).

Translated from Opt. Spektrosk., 24: 671-6(May 1968).

The radial distribution of electron concentrations and of the emission intensity, as well as the wall currents in a contracted high-frequency discharge in argon were measured. The results of these measurements are compared with the theory of a contracted positive column. (auth)

50140 THEORY AND THE DIAGNOSIS OF THE ELECTRODELESS DISCHARGE. Keefer, Dennis Ralph. Gainesville, Fla., Univ. of Florida, 1967. 101p.

Thesis.

An analysis of the asymmetric double probe is described which permits the measurement of electron temperature, electron number density, and plasma potential in an electrodeless discharge. Experiments were performed which indicate that the electron temperature and ionization function are essentially uniform across the discharge radius. These results are at variance with commonly made assumptions concerning the discharge. An analysis of the energy transport in the discharge predicts that, due to the thermal conduction of the electron gas, the temperature is essentially uniform. The fact that the electron temperature is uniform is used as a basis for the formulation of a one-dimensional, steady-state theory for the inductively driven electrodeless discharge. The results of the theory permit the calculation of electron temperature, electron number density, the electric and magnetic fields in the discharge, and the power input to the discharge as a function of the discharge configuration and the applied coil current. An important result of the theory is the prediction that electron temperature is independent of the input power, and that the electron number density is a direct function of the solenoid coil current. (Disser. Abstr.)

50141 PLASMA DIAGNOSTICS USING A LOADED WAVEGUIDE. Kinney, Ralph Arden. Gainesville, Fla., Univ. of Florida, 1967. 107p.

Thesis.

This dissertation is concerned with propagation in a plasma-loaded waveguide. The plasma is assumed to be isotropic. The axial variation of the electron density is assumed to consist of a semi-infinite extent of uniform density connected to an air dielectric region by a transition, or boundary, zone wherein the plasma number density varies from zero to the uniform value. A study was made of methods of solving for the electromagnetic fields in such a waveguide. By using combinations of two exponentially varying electron-density profiles it was possible to approximate complicated electron variations in the transition zone. Bessel functions with complex order, typical of solutions in the transition zone, were presented graphically for use in such approximations. In addition, a study was made of the use of the complex reflection coefficient as a plasma diagnostic tool. It was found that for the case where the waveguide was not cutoff, the magnitude of the reflection coefficient, R, was not sensitive to the profile used in the transition zone. However, R was found to be sensitive to the width of the transition zone. The phase of the reflection coefficient, ϕ_R, was found to be sensitive to both profile and boundary zone width. For electron densities large enough to cause the waveguide to be cutoff, roughly described by $\omega_p > \omega$, it was found that while both ϕ_R and R were less dependent upon the width of the transition zone, both quantities were profile sensitive. (Disser. Abstr.)

50142 A SPECTROMETRIC INVESTIGATION OF AN ELECTRODELESS DISCHARGE. Pell, Kynric Martin. Gainesville, Fla., Univ. of Florida, 1967. 83p.

Thesis.

The electron temperature distribution in a nonequilibrium, low-pressure, electrodeless discharge was determined experimentally. In view of the lack of excitation function data for complex atoms, such as argon which was used in this study, an approximate semi-corona model was used. The temperature dependence of excited state population densities for neutral atoms and singly ionized ions predicted by the approximate model was used to obtain a relationship between the intensity ratio of two emission lines and the temperature. Integrated intensity distribution data were inverted numerically to obtain the radial dependence of the intensity. Ratios of the intensity of an ion emission line and an atom emission line at 25 radial locations in the plasma were used to obtain the temperature distributions. Maximum temperatures, found on the axis of symmetry, ranged from 1.24 to 1.54 eV for a range of operating pressures from 50 to 1000 μ of mercury. The radial dependence of the temperature was found to be quite weak. The temperature decreases approximately 15% over a region equal to ⅔ of the radius of the plasma. (Disser. Abstr.)

Kinetics of Plasma

50143 (IPP-6/67) HIGH TEMPERATURE PLASMA WITH A COLD GAS BLANKET IN A TOROIDAL MAGNETIC FIELD.

Berghahn, H. H.; Feneberg, W.; Karger, F.; Venus, G. (Institut fuer Plasmaphysik, G.m.b.H., Garching (West Germany)). July 1968. 20p. (IPP-3/76). Dep.

The maximum attainable plasma temperature in a linear high-current high-density arc with a longitudinal magnetic field is limited by the end losses. In a plasma torus, end losses do not occur. There is, however, the question of what influence the curvature has on the plasma, i.e., whether an arc in a toroidal magnetic field can burn in a stable manner in the center of the vessel or whether it is displaced to the wall, and how large the energy losses and axial temperature are, compared with those of an arc in a linear magnetic field. To solve this problem by using the classical heat conduction equations for ions and electrons, the temperature profile resulting from ohmic heating was calculated as a function of time. Since the thermal conductivity parallel to the magnetic field is high, the temperature in the hot regions is constant on the magnetic surfaces. The magnetic surfaces are formed by superposition of the magnetic field produced by the discharge current on the high longitudinal field. The rotational transform thus obtained ensures that the plasma is in equilibrium. The position of the plasma is given by the wall isotherms. As a preliminary study of the conditions in the whole torus, two independent experiments with torus sectors for investigating discharges in hydrogen and helium were conducted. The experimental data are as follows: torus diameter 1 m (30° sector) and 0.7 m (180° sector), plasma diameter ~3 cm, plasma density 10^{15} to 10^{16} cm^{-3}, discharge current 3 kA, discharge time 1 msec and 20 msec, respectively, and external magnetic field 50 and 25 kG, respectively. The results of the experiment are as follows: (a) The hot regions of the plasma (axial temperatures up to about 100,000°K) are not forced to the outer wall, as widely feared, but rather tend to be slightly displaced to the inner wall. (b) Using streak pictures in the light of He(II) (λ = 4686 Å) it is found that, with a suitable choice of parameters, the arc is stable. (c) The losses in the toroidal discharge are not much higher than in the linear case, as measurements of the longitudinal electric field strength and axial temperature show. The results of the calculations and the two experiments arouse hopes of obtaining a stationary high-temperature plasma free of MHD instabilities by neutral gas confinement in a closed torus with a superposed magnetic field. (auth)

50144 (JINR-P9-3978) INTERACTIONS OF LANGMUIR AND ACOUSTIC WAVES IN TURBULENT PLASMA. Makhan'kov, V. G.; Tsytovich, V. N. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Computing Techniques and Automation). 1968. 28p. (In Russian). Dep.

Studies of the interactions in fully ionized turbulent plasma show that in case of steady-state and sufficiently broad spectra of intense Langmuir waves such interaction is of destructive character. (R.V.J.)

50145 (JINR-P9-3979) NONLINEAR INSTABILITIES OF LANGMUIR WAVES IN THE REGION OF FREQUENT COULOMB COLLISIONS. Makhan'kov, V. G.; Tsytovich, V. N.; Shchinov, B. G. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Computing Techniques and Automation). 1968. 17p. (In Russian). Dep.

Effects of pair-Coulomb interactions on linear effects in a completely ionized plasma (in region of $\omega_- > k_- \nu_{Ti}$) were investigated. Data obtained show that in the examined ω_- area variation of the spectral transfer is possible under the conditions of kinetic nonlinear instability even for not very intense Langmuir oscillations. The qualitative character of nonlinear hydrodynamic instability of narrow intense Langmuir packets is discussed. (tr-auth)

50146 (JINR-P9-4040) EFFECT OF THE COULOMB COLLISIONS OF PARTICLES ON THE NONLINEAR TRANSVERSE WAVE INTERACTIONS. Makhan'kov, V. G.; Shchinov, B. G. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Computing Techniques and Automation). 1968. 10p. (In Russian). Dep.

The effect of the Coulomb collisions on the nonlinear interactions of transverse waves is considered. It is shown that the method developed for the Langmuir waves can be easily transferred on the case in question. (auth)

50147 (LA-3803) HAMILTON'S PRINCIPLE AND NUMERICAL SOLUTION OF THE VLASOV EQUATIONS. Lewis, H. Ralph (Los Alamos Scientific Lab., N. Mex.). Oct. 1967. Contract W-7405-eng-36. 15p. Dep. CFSTI.

It is demonstrated how Hamilton's principle can be used to derive equations that approximate the Vlasov integro-partial differential equations. The Lagrangian that is used is sufficiently general to describe physical systems in which there are present any of a large class of material media that exhibit nonlinear polarizability and magnetizability. The aim is to obtain useful approximate equations that are more convenient for numerical solution than the exact integro-partial differential equations. The approximate equations that are emphasized are a system of ordinary differential equations in time, although the basic method can be used to derive other approximate equations, such as a system of difference equations. The basic method can be applied to any Lagrangian system. The equations for a simple, one-dimensional example are displayed explicitly. (auth)

50148 (N-68-18485) ENHANCEMENT OF ION CYCLOTRON WAVES IN HYDROGEN-HELIUM MIXTURES. Hettel, Henry J.; Krawec, Roman; Prok, George M.; Swett, Clyde C. (National Aeronautics and Space Administration, Cleveland, Ohio. Lewis Research Center). Mar. 1968. 35p. (NASA-TN-D-4271). CFSTI.

The admixture of helium to a hydrogen plasma atmosphere has increased the radiofrequency power absorption in the ion-cyclotron mode. Measurements of power absorption, plasma radius, electron density, and magnetic flux density at the peak power point were obtained as a function of plasma composition. A relation was derived involving these experimental parameters and the ion density. It is shown that the observed power enhancement can be explained if it is assumed that the metastable states of the helium atoms react with hydrogen atoms and molecules to increase the plasma ion density. (auth) (STAR)

50149 (RISO-175) ON THE VISCOSITY AND HEAT CONDUCTIVITY OF A COLLISIONLESS PLASMA IN A MAGNETIC FIELD. Milantiev, V. P. (Danish Atomic Energy Commission, Risoe. Research Establishment). Mar. 1968. 20p. Dep.

The viscous stress tensor and the heat flux tensor of a collisionless plasma immersed in a strong magnetic field are calculated by Grad's moments method. No contradiction is found between the expressions of the viscous stress tensor obtained earlier by A. Macmahon and by A. Simon and W. Thompson. It is shown that in the approximation considered the "longitudinal" heat flux is absent. (auth)(Denmark)

50150 (SC-DC-68-2404) INITIAL RESULTS FROM A TWO DIMENSIONAL LAX-WENDROFF HYDROMAGNETIC CODE. Freeman, J. R.; Lane, F. O. Jr. (Sandia Corp., Albuquerque, N. Mex.). Aug. 1968. Contract AT(29-1)-789. 16p. (CONF-680914-1). Dep. CFSTI.

From Plasma Simulation Conference, Los Alamos, N. Mex.

The success of a number of one-dimensional hydromagnetic codes in predicting the gross dynamical behavior of a variety of plasma devices has led to an attempt to extend the calculations to two dimensions. An explicit Eulerian difference scheme of the Lax-Wendroff variety was chosen to provide a reasonable level of accuracy for a relatively coarse space-time net. A staggered array with provision for fixed regions of fine zoning was used. Numerical stability was achieved by using a third-order smoothing technique reported recently by Lapidus. All calculations assumed currents which were directed solely in the theta direction. A simple two-dimensional high-density theta pinch, incorporating a mirror field at the ends, was chosen as a test example. The hydromagnetic equations included the effects of thermal conduction and a temperature-dependent electrical conductivity. Separate ion and electron temperatures were calculated. Computed results for this example are shown. (auth)

50151 A STUDY OF DIRECT SOLUTION ANALYSIS WITH A NEW HOLLOW-CATHODE DISCHARGE SYSTEM. Zanzucchi, Peter John. Urbana, Ill., Univ. of Illinois, 1967. 199p.

Thesis.

The new concept of generating a highly reactive molecular filler gas by the hollow-cathode discharge for the sensitive, quantitative excitation of solutes (cations) in microliter volumes of solution sample has been demonstrated using a demountable hollow-cathode source. The lining of the hollow cathodes with potentially reactive materials (e.g., graphite) provides for unique chemical-physical filler gas systems. As a result of the studies with the demountable hollow cathode and chemically active filler gases, a direct solution technique for sampling has been developed. In general, the sampling of solutions directly eliminates analytical dependence on conventional sputtering mechanisms which could influence the precision of the method. The direct solution sampling technique provides good short-term, efficient (bulk) emission and thus contributes to good sensitivity. Specifically, a carbon monoxide system is generated internally by the discharge from the interaction of molecular oxygen gas and a cylindrical graphite cathode liner electrode. With this chemical-physical environment, there is intense short-term (seconds) characteristic atomic emission upon the direct injection of microliter quantities of aqueous solution samples. The absolute sensitivity is in the nanogram or less range for selected pure test materials such as sodium (sodium chloride), copper (cupric acetate and cupric chloride) and magne-

sium (metal). Analytical studies with solutions of dissolved stainless steel samples have established a practical analysis for boron at 0.1 to 1 nanogram levels. Observations of gross matrix effects show that certain atomic and molecular species have a strong effect on the chemical behavior and emission intensity of the test material, e.g., simple organics decrease the emission intensity and sodium strongly increases the emission intensity. The overall study indicates the possible use of the hollow-cathode system as a fast, direct, convenient and sensitive microanalytical technique for solution analysis. Also there is evidence that some of the reactions observed in the hollow-cathode discharge relate directly or indirectly to other spectrochemical methods. Finally, this work suggests a direction for further research utilizing the hollow-cathode discharge to produce highly reactive chemical–physical systems, and illustrates how such systems could provide for unique spectrochemical techniques. (Disser. Abstr.)

50152 THEORETICAL STUDY OF THE INTERACTION OF ACOUSTIC WAVES WITH A PLASMA. Aubrecht, L. (Czech Technical Univ., Prague). Phys. Lett., 27A: 526-7(Sept. 9, 1968).

The interaction between a sound wave and a partially ionized gas in the presence of a dc electric field is being investigated. The collision of charged particles with neutrals and their macroscopic motion are taken into account. (auth)

50153 ELECTRON ENERGY DISTRIBUTION IN THE PRESENCE OF MOVING STRIATIONS. Drouet, M. G.; Sicha, M.; Cloutier, G. G. (Univ. of Montreal). Phys. Lett., 27A: 496-7 (Sept. 9, 1968).

Probe measurements obtained in moving striations reveal large variations of the plasma potential and indicate that the Maxwellian approximation is valid for the body of the electron energy distribution. (auth)

50154 GENERALIZED ELECTRON CYCLOTRON RESONANCE IN WEAKLY IONIZED PLASMAS. Stiller, W. (Arbeitstelle fuer Statistische Physik, Leipzig). Phys. Lett., 27A: 478-9(Sept. 9, 1968).

A generalized electron cyclotron resonance phenomenon in weakly ionized plasmas under the action of an alternating electric field and a circularly polarized magnetic field is theoretically found. (auth)

50155 IONIC MODULATION OF THE TONKS–DATTNER RESONANCES IN A SELF-MAINTAINED PLASMA. Moisan, M.; Leprince, P. (Laboratoire de Physique des Plasmas, Orsay, France). Phys. Lett., 27A: 545-7(Sept. 9, 1968). (In French).

By injecting a few watts of rf power into a Tonks–Dattner resonance, the plasma thus created exhibits a frequency modulation of the rf signal. At low pressure, the modulation frequency is close to the ionic plasma frequency. (auth)

50156 PLASMA PROPERTIES OF KILOAMPERE DISCHARGES. Creedon, John E. (Army Electronic Command, Fort Monmouth, N. J.). IEEE (Inst. Elec. Electron. Eng.) Trans. Electron. Devices, ED-15: 396-402(June 1968).

Plasma properties and characteristics of interest to high-current switching devices were investigated. Peak pulse currents up to 80,000 A were used to generate dense plasmas in linear glass-metal diodes. Two tube diameters, 3 and 7.5 in., were studied. In the case of the 3-in. dia diode, the electrode separation was varied from 10.6 to 25.1 cm. Hydrogen gas was studied in the pressure range from 0.5 to 40 torr. Electron densities and temperatures were determined using spectroscopic techniques. Densities were found to be in the 10^{16} to 10^{17} cm^{-3} range. Plasma resistivities were determined from a knowledge of the density and temperature. The observed dependence of resistivity on current and pressure is discussed and the results compared with resistivities obtained from tube-drop measurements. The effects of impurities and instabilities are also discussed. (BBB)

50157 ENERGY TRANSPORT BY RADIATION WITH ABSORPTION IN CYLINDRICAL ARCS. Hermann, W. (Technische Hochschule, Munich). Z. Phys., 216: 33-51(1968). (In German).

For temperatures above 12,000°K the contribution of nontransparent radiation becomes very important for the energy transport in argon and nitrogen arc plasmas. Formulas for the radiation flux and the difference between emission and absorption of radiation per unit volume and time are given generally and furthermore for arcs of cylindrical symmetry. For argon arcs at normal pressure with axial temperatures between 10,000 and 16,000°K the radiative behavior is investigated and the share of transparent and nontransparent radiation on the total energy flux is computed. The influence of different assumptions made on the amount of emission and absorption on the E(I) characteristic and the radial temperature distributions is shown. (auth)

50158 EXCITATION OF "RED" AND "VIOLET" SATELLITES IN INSTABILITY OF ALFVEN WAVES. Karplyuk, K. S.; Oraevskii, V. N.; Pavlenko, V. P. (Inst. of Physics, Kiev). Ukr. Fiz. Zh., 13: 1114-17(July 1968). (In Russian).

A possible interrelation of three plasmon processes at a decay instability of Alfvén waves is analyzed. It is shown that in this decay the Alfvén wave and slow magneto-acoustic one and also a fast magneto-acoustic wave of a higher frequency than that of an initial wave are excited simultaneously. A dissipation effect on the initial wave stability is also studied. It is shown that instability of the initial wave may arise regardless of a fairly strong dissipation. Such instability is defined as a decay-dissipative one. An order of the magnitude of the growth rate of the decay-dissipative instability is by a factor of ν_p/Γ lower than that of the decay instability. (auth)

50159 MICROWAVE PHENOMENA IN THE LONG GAS DISCHARGE WITH SMALL TRANSVERSE DIMENSIONS. Filonenko, E. G. (Kiev State Univ.). Ukr. Fiz. Zh., 13: 1181-4(July 1968). (In Russian).

The microwave oscillations were studied in a low-pressure arc discharge under conditions when the anode–cathode distance was much longer than the transverse dimensions of this system. It is shown that the stream of the primary electrons interacts with the discharge plasma due to a synchronous mechanism. The frequency of the observed oscillations is lower than the Langmuir one, being reduced due to the transverse dimensions of the system. This interaction is sufficiently strong to obtain some real amplification of a microwave signal. The electron stream relaxation and the change of its distribution due to the interaction with the plasma oscillations were also investigated. (auth)

50160 INFLUENCE OF THE TEMPERATURE ON THE WAVE PROPAGATION IN A BOUNDED PLASMA. Karplyuk, K. S.; Oraevskii, V. N. (Inst. of Physics, Kiev). Ukr. Fiz. Zh., 13: 1077-82(July 1968). (In Russian).

Dispersion equations for volume and surface high-frequency waves in a bounded plasma are obtained. It is shown that only in the non-zero temperature approximation it is possible to satisfy boundary conditions for a normal component of the mass velocity. (auth)

50161 MAGNETOHYDROMAGNETIC WAVES IN A CYLINDRICAL PLASMA COLUMN. Karplyuk, K. S.; Kolesnichenko, Ya. I.; Oraevskii, V. N. (Inst. of Physics, Kiev). Ukr. Fiz. Zh., 13: 1072-6(July 1968). (In Russian).

Oscillations are investigated of a plasma column contained in vacuum by the longitudinal magnetic field. The dispersion equations describing volume and surface magnetohydromagnetic waves, which cause the plasma boundary to be perturbed, are obtained and analyzed. It is shown that in a plasma column there are also waves having an arbitrary radial profile, which propagate without perturbing the plasma boundary. (auth)

50162 ON THE REFLECTION OF AN ELECTROMAGNETIC WAVE FROM A MAGNETOACTIVE PLASMA IN THE INCLINED INCIDENCE. I. Kondratenko, A. N.; Onishchenko, I. N. (Inst. of Physics and Tech., Kharkov). Ukr. Fiz. Zh., 13: 1245-53(Aug. 1968). (In Russian).

The question of inclined incidence of an electromagnetic wave on a semiconfined magnetoactive plasma with a sharp boundary is considered. Reflection and absorption coefficients for diffuse and inverse particle reflection from the boundary are found for the cases of high-frequency and low-frequency oscillations. It is shown that the absorption coefficient increases with the increase of the incident angle and reaches the maximum value at the angle $\theta \sim \pi/2$; at the angle $\theta \neq 0$ for the inverse reflection the absorption coefficient is proportional to ν_e/c, whereas at the angle $\theta = 0$ it is proportional to $(\nu_e/c)^3$. For the low-frequency oscillations surface absorption is caused mainly by ion motion. (auth)

50163 ON PENETRATION OF THE LONGITUDINAL ELECTRIC FIELD INTO A MAGNETOACTIVE PLASMA. Kondratenko, A. N.; Onishchenko, I. N. (Inst. of Physics and Tech., Kharkov). Ukr. Fiz. Zh., 13: 1282-91(Aug. 1968). (In Russian).

The penetration of the longitudinal electric field into a plasma slab in a constant magnetic field parallel to the plasma boundaries is considered in the kinetic approximation. The excitation conditions were determined and the form of the field in plasma for the cases of the cyclotron and hybrid plasma frequencies is found. A weak and strong space dispersion is considered. (auth)

50164 FREQUENCY DEPENDENCE OF RELAXATION TIME OF HIGH-DENSITY ELECTRONS. Andreev, V. V. (Inst. of Physics and Tech., Kharkov). Ukr. Fiz. Zh., 13: 1320-6(Aug. 1968). (In Russian).

High-frequency electroconductivity of a degenerate Fermi gas

of high-density electrons in a uniform field is considered. Electron scattering by fixed, chaotically disposed ions is taken into account in the second order of the perturbation theory, the Coulomb potential being screened by the electron–electron interaction. A dependence is obtained of the relaxation time of the electrons τ on frequency of the field ω in the frequency range $\omega\tau \gg 1$ at the absolute zero temperature. (auth)

50165 ON THE INFLUENCE OF ELECTRIC FIELD LONGITUDINAL COMPONENT ON IONIZING SHOCK WAVES IN GAS. Barmin, A. A.; Kulikovskii, A. G. Izv. Akad. Nauk SSSR, Mekh. Zhidk. Gaza, No. 3, 133-4(May-June 1968). (In Russian).

The quantitative influence of longitudinal electric fields on ionizing shock waves in an ideal gas was calculated when no magnetic field was present. (R.V.J.)

50166 TIME-DEPENDENT BEHAVIOR OF A CLASS OF NONEQUILIBRIUM RADIATING SYSTEMS. Gelinas, R. J. (Univ. of California, Livermore). Phys. Rev., 175: 300-13 (Nov. 5, 1968).

A kinetic-theoretic approach is employed to analyze the temporal behavior of simple radiating systems that are, generally, not at equilibrium. The system models considered herein are simple in the sense that streaming of radiation and particles (hydrogenic atoms) is neglected, relativistic effects are not considered, and bound-bound radiative transitions are taken to be the dominant interaction process. Of major concern is the manner in which physically interpretable factors bear on the approach of mean (singlet) densities of atoms in various states and of photons to their steady-state values. Additionally, the present work is of sufficient generality, statistically, to allow the retention of higher-order densities. That is, mean square (doublet) densities for the atoms in their various states and for the radiation (this includes joint doublet densities between species) are explicitly included. These additional terms comprise the vehicle that statistically couples the various distributions in a system to the next-higher order (than the first). The cases for which solutions have been obtained are parametrized by radiation linewidths, by statistical weights of atomic levels, and, of course, by initial conditions on the atomic and radiation densities. Major trends and characteristic results are noted and mechanistically discussed; and elemental limits on the application and interpretation of the kinetic theory, for this class of radiating systems are indicated. (auth)

50167 PARAMETRIC APPROACH TO THE GROUND-STATE ENERGY OF AN ELECTRON GAS. Becker, M. S.; Broyles, A. A.; Dunn, Tucson (Univ. of Florida, Gainesville). Phys. Rev., 175: 224-8(Nov. 5, 1968).

A parametric form is chosen for the ground-state wave function of an electron gas. The expression for the energy of the system is derived and then minimized with respect to the unknown parameters. The energies thus obtained agree well with the results of other authors. (auth)

50168 CALCULATION OF THE DEPENDENCE OF EMITTED LIGHT ON CHARGE DENSITY FOR TWO-ELECTRON COLLISIONAL–RADIATIVE RECOMBINATION IN THE HYDROGENIC APPROXIMATION. Collins, C. B. (Southwest Center for Advanced Studies, Dallas). Phys. Rev., 175: 160-74(Nov. 5, 1968).

The relationship expected between excited-state populations resulting from two-electron collisional–radiative recombination and the free-electron density has been examined with the objective of determining relative orders of dependence. It was found that the behavior of excited-state populations divided them into three groups on the basis of principal quantum number. The members of the lowest group of quantum numbers were found to have a dependence of population on charge density proportional to the product of the recombination rate coefficient and the square of the electron density. The members of the highest group of quantum numbers were found to have a second-order dependence on electron density. The intermediate group showed a dependence which itself was strongly electron-density-dependent and which ranged from second- to greater than third-order dependence on charge density. (auth)

50169 RELAXATION PROCESSES AND AMPLIFICATION OF RADIATION IN A DENSE PLASMA. Gordiets, B. F.; Gudzenko, L. I.; Shelepin, L. A. (Lebedev Inst. of Physics, Moscow). Zh. Eksp. Teor. Fiz., 55: 942-50(1968). (In Russian).

Some features of relaxation in a dense low temperature highly ionized plasma of a many-electron chemical element are discussed. It is shown that in such a medium the decisive role of collision transitions and the competition of various relaxation channels lead (under certain conditions) to inverse population of a number of levels which is practically independent of the probabilities for spontaneous radiative transitions involving frequencies in the infrared or visible spectra and also of reabsorption of the radiation. This is an important property of lasers with a dense, highly ionized plasma (plasma lasers). The negative absorption coefficient in such a medium is very large. Numerical calculations for the case of recombining lithium plasma illustrate the feasibility of the conditions formulated in the paper. (auth)

50170 SELF-FOCUSING OF AN ION–ACOUSTIC WAVE IN A PLASMA. Petviashvili, V. I. Zh. Eksp. Teor. Fiz., 55: 917-23 (1968). (In Russian).

The propagation of weak long wave disturbances in a plasma in the presence of a periodic ion–sound wave (PW) in it is analyzed by an asymptotic method. It is shown that a plasma with a PW is unstable with respect to buildup of such disturbances which move at a large angle with respect to the PW. The time of development of a PW instability is found to be much smaller than the sound wave inversion time. (auth)

50171 EQUILIBRIUM OF A PLASMA PINCH IN A TOROIDAL CONSTANT MAGNETIC FIELD AND A HELICAL HIGH-FREQUENCY MAGNETIC FIELD. Gutkin, T. I.; Lozovskii, S. N.; Boleslavskaya, G. I. (Physical-Technical Inst., Sukhumi, USSR). Nucl. Fusion, 8: 109-20(May 1968).

The equilibrium of a toroidal plasma pinch is considered in a constant magnetic field on which is superposed a helical high-frequency field produced by helical currents flowing on a toroidal surface with major radius R and minor radius r_k. The helical currents are proportional to $\exp[i(\omega t - n\psi - k_{\parallel}\zeta)]$, where ω is the frequency imparted by the generator, ψ the polar angle in the meridional cross-section of the torus, and ζ is the length of arc along the major circumference of the torus. It is demonstrated that it is possible to achieve equilibrium with high-frequency field pressures less than the kinetic pressure of the plasma. An expression is derived for the displacement of the pinch in the equilibrium state as a function of high-frequency field amplitude, plasma kinetic pressure, the multipolarity n, and such geometric parameters as the radius of the plasma pinch r_p, the radius of the circuit r_k and the radius of the torus R. In the helical high-frequency field, the equilibrium of the plasma pinch depends to a great extent on the strength of the constant magnetic field H_0, the plasma concentration N, the frequency of the variable field $f = 2\pi/\omega$, and the wavelength of the helical current $\lambda_{\parallel} = 2\pi/k_{\parallel}$. The helical high-frequency electromagnetic field within the plasma is a superposition of two wave types. When $H_0 < H_{crit.} = \sqrt{4\pi MN}\Delta_{\parallel}$ the first type of wave transfers to the skin, and when $H_0 > H_{crit.}$ it propagates. When $k_{\parallel}t_p \ll 1$ and $k_{\parallel}r_p \ll H_0/H_{crit.}$ the field of the second type of wave differs only slightly from a vacuum field. In the region where the first type of wave transfers to the skin, the displacement Δ of the plasma pinch decreases with increasing H_0 and becomes zero when $H_0 = H_{res} = (1\sqrt{2})H_{crit.}$; with further increases in the magnetic field strength Δ becomes negative. $H_0 = H_{res}$ is the condition for resonance excitation of the helical high-frequency field within the plasma. The most effective use of high-frequency power for equilibrium containment of the plasma pinch within the torus is to be expected near this resonance on the side where $\Delta > 0$. The change in the sign of Δ is a consequence of a change in the direction of the force acting on the plasma. If there are two types of wave in the plasma, there appear — in addition to the forces associated with the pressure of each individual wave — forces produced by the interaction of the currents excited by one wave type with the field of the other wave type, and vice versa. For certain parameter values, the phase relations of the fields and currents may be such that the additional forces associated with the cross interaction may work in a direction opposite to that of the forces produced by the pressure of each individual wave. In the propagation region of the first wave, i.e., where $H_0 > H_{crit.}$, positive and negative values of the plasma pinch displacement alternate (i.e., there are alternating regions of stable and unstable equilibrium respectively). (auth)

50172 EFFECT OF INELASTIC ATOMIC COLLISIONS ON RELAXATION PROCESSES IN A LOW-TEMPERATURE PLASMA. Presnyakov, L. P.; Ulantsev, A. D.; Shelepin, L. A. Opt. Spectrosc. (USSR) (Engl. Transl.), 24: 363-4(May 1968).

Translated from Opt. Spektrosk., 24: 677-9(May 1968).

The effect of interatomic collisions on the relaxation of the populations of discrete atomic levels is examined. On the basis of the estimates obtained for the cross section for collisions with energies of 0.1 to 1 eV, it is shown that interatomic collisions must be taken into account in the relaxation equations even at ionization fractions of 10^{-6} to 10^{-4}. (auth)

50173 ACCELERATION OF PLASMA WITH TRAVELING ELECTROMAGNETIC WAVES. Bieger, W.; Gresser, H.; Hoenen, F.; Laeuter, R.; Richter, F.; Stampa, A.; Tuczek, H. (Institut fuer Plasmaphysik der Kernforschungsanlage, Juelich, Ger.). Z. Naturforsch., 23a: 263-70(Feb, 1968). (In German).

With regard to the application in plasma wind tunnels or propul-

sion devices, the electrodeless generation and acceleration of plasma by an electromagnetic wave traveling along a special transmission line are investigated. Information on the interaction of the wave with the plasma was obtained, and initial parameters for effective operation were determined. In the first experiments the efficiency of the process was not a primary concern. The transmission lines were terminated in matched loads where the whole electromagnetic energy at the output of the circuit, of the order of 100 MW, was dissipated. Such devices are operated only in a pulsed manner, because it is practically impossible to maintain such high energies for long periods of time. Plasma pulses with a length of about 1 m, densities up to 10^{14} cm^{-3}, and particle velocities between 5×10^8 cm/sec and 1.2×10^9 cm/sec were produced. The interaction of wave plasma was described in good agreement with a simple model in which the ions of the plasma were assumed to be reflected elastically on a magnetic piston. For the production of longer or continuously streaming beams it appears necessary to go over to a feedback circuit, where the energy at the output of the line is reinjected at the input by using an appropriate transformer. A high-frequency oscillator is used to compensate the energy losses resulting from ohmic effects and from the plasma acceleration. The realization of such a circuit was studied theoretically and experimentally. (auth)

50174 MATHEMATICAL STUDY OF THE ELECTRON DECAY IN DIFFUSION AND RECOMBINATION CONTROLLED AFTERGLOWS. Frommhold, Lothar (Univ. of Texas, Austin); Biondi, Manfred A. Ann. Phys. (N. Y.), 48: 407-40(July 1968).

The continuity equation for electrons in a decaying plasma is solved numerically in three dimensions including a loss term quadratic in the electron density (i.e., two-body electron–ion recombination) and an ambipolar diffusion term. The geometries investigated are the finite cylinder, the rectangular parallelepiped, and some one-dimensional cases. The electron densities are averaged assuming weighting functions corresponding to various microwave probing field distributions (cylindrical TM_{010}, TE_{011}, and TE_{111} and rectangular TE_{101} modes) and are therefore directly proportional to measured quantities, such as resonant frequency shifts, obtained in microwave afterglow studies of recombination. Three different initial electron distributions are used, corresponding to a uniform (recombination controlled), a fundamental diffusion mode and a somewhat more spatially constricted distribution. The linear range of the computed (averaged densities)$^{-1}$-versus-time curves is determined and correction factors are derived which, if applied to the observations, yield the corrected recombination coefficients from the curves. The corrections derived in the two- and three-dimensional analyses are found to be significantly larger than those obtained in the one-dimensional analyses. Also, when considering plasma containers of different shapes but of the same fundamental diffusion length, a larger surface/volume ratio is found to be equivalent in effect to an increased diffusion coefficient in the predicted decays. In most cases of practical interest, though, a much stronger dependence upon the varying probing field distributions is found when different container or cavity dimensions are to be compared. When the present analysis is applied to one-dimensional geometries, recombination corrections in agreement with the results of Gray and Kerr are obtained. (auth)

50175 DISCHARGE POLARIZATION OF ^{3}He GAS. McCall, Gene Heath. Princeton, N. J., Princeton Univ., 1968. 113p.

Thesis.

Substantial nuclear polarization effects were produced by maintaining a discharge in a ^{3}He sample when placed in a magnetic field. Although it may be thought that the effect of a discharge would be to increase the electron temperature and bring about relaxation to a small Boltzmann population difference, it was found that enhancements of nuclear polarization of greater than 2000 could be obtained. Also, a study of the magnetic field dependence of the effect has shown that it is possible to have a negative spin temperature, or inverted population in certain ranges of the magnetic field. The maximum polarization obtained was 0.06%, which corresponds to an enhancement of 2200 at 1 kG. The nuclear polarization was measured by nuclear magnetic resonance. Several experiments were performed to determine the sources of this effect. The influence of impurities, of changing the time dependence of the discharge, and of changing the gas temperature were examined, and the polarization of the discharge light was measured. The results of these experiments indicated that the 2^3S_1 metastable state was involved in the polarization process. The most promising theoretical explanation for the effect seems to be to regard the 2^3S_1 levels as being saturated by collisions with hot electrons and then undergoing metastable ground-state collisions, accompanied by metastability exchange, characterized by a much cooler kinetic temperature. The magnetic field dependence of the electron and atomic collision cross sections were calculated, and the resulting set of eight nonlinear rate equations were solved by computer to give the ground-state polarization as a function of magnetic field. The theory gives order of magnitude agreement with experiment, but it does not account for most of the fine structure in the magnetic field dependence of the polarization. The theory does indicate that substantial polarization should exist at high magnetic fields, and that the effect should be enhanced in this region by the use of low gas temperature, higher discharge currents, and high field homogeneity. The negative temperature polarization which has already been produced, however, is adequate to run a Zeeman maser. (Disser. Abstr.)

50176 MICROWAVE CONDUCTIVITY OF PLASMAS: RELATIVISTIC REFINEMENTS AND COLLECTIVE THEORY. Kim, Dae Mann. New Haven, Conn., Yale Univ., 1967. 156p.

Thesis.

Some aspects of the interaction of radiation with fully ionized plasmas are studied. The first part consists of a general survey of the problem. Some refinements on the expression for the conductivity by means of kinetic theory were obtained in the second part. The final part of the thesis is concerned with the collective motions of charged particles. The static, as well as the dynamic, shielding of the particles and their effect on the conductivity expression are investigated via the diagram technique of Prigogine. (Disser. Abstr.)

50177 QUANTUM MECHANICAL THEORY OF NONLINEAR PLASMA PHENOMENA IN A MAGNETIC FIELD. Walters, Gary Max. Knoxville, Tenn., Univ. of Tennessee. 125p.

Thesis.

Various types of nonlinear plasma phenomena in a strong magnetic field are considered by using a quantum mechanical description of the system. The same plasma model is used throughout. The model is similar in some respect to the plasma in the DCX-2 injection experiments at the Oak Ridge National Laboratory. The model is the following: there is a distribution of energetic ions embedded in a relatively cold, infinite, neutralizing background. Here, the cold plasma produced by ionizing the background gas may be one or two orders of magnitude more dense than the energetic ions resulting from disscciation of the injected beam in DCX-2. On the basis of this picture, the cold background plasma is considered as the medium through which the waves propagate and the energetic particles are considered as those particles which interact strongly with the waves. The plasmon–particle and plasmon–plasmon processes are considered. The quasi-linear and mode-coupling equations are obtained. The possibility of a spacial gradient instability, that of Mikhailovskii and Timofeev arises and is interpreted in terms of stimulated emission and absorption of plasmons by energetic particles. The interaction of a particle with a plasma in a strong magnetic field is considered from the viewpoint of fluctuation theory. The results imply the existence of the plasma–particle interaction Hamiltonian for a plasma that is in thermal equilibrium. The quasi-linear equations for the interaction of particles with circularly polarized waves are obtained. Special attention is given to the quasilinear theory of the Alfvén cyclotron instability. The interaction of light with a plasma in a magnetic field is considered from the viewpoint of fluctuation theory. The results imply the existence of a plasmon–photon interaction Hamiltonian for a plasma in thermal equilibrium. The problem of emission and absorption of radiation by relativistic particles is considered. Solutions to the Dirac Hamiltonian in a uniform magnetic field are obtained. The interaction Hamiltonian for particles and the radiation field is obtained for waves propagating perpendicular to the magnetic field. The problem is then separated into the interaction of particles with the ordinary and extraordinary waves. (Disser. Abstr.)

50178 ON INSTABILITIES ASSOCIATED WITH THE INTERACTION OF RELATIVISTIC ELECTRONS WITH ELECTROSTATIC WAVES PROPAGATING NEARLY PERPENDICULAR TO A STATIC MAGNETIC FIELD. Blanken, Ronald Alfred. Princeton, N. J., Princeton Univ., 1968. 95p.

Thesis.

The microwave emission characteristics of a two-component electron plasma were examined in the frequency range about the second harmonic of the nonrelativistic electron gyrofrequency Ω_e. The two-component distribution consists of a tenuous hot component which has a loss cone distribution and a dense finite temperature background component. Two types of emission are observed. The first occurs at the Bernstein resonance with $\omega \geq 2\Omega_e$. Anomalous diffusion into the loss cone is associated with this emission. The observed frequency of the second mode satisfies $\omega_{uh} \sim 2\Omega_e$ where $\omega_{uh}^2 = \omega_p^2 + \Omega_e^2$ and Ω_h is the relativistic electron gyrofrequency and ω_p^2 is the electron plasma frequency. No enhanced loss of hot electrons is observed with the second type of

emission. A theory is developed which treats the unstable interaction of a relativistic distribution of electrons with short-wavelength electrostatic waves propagating nearly perpendicular to the static magnetic field $\underline{B}$. The theory predicts the growth rate as a function of the wave frequency and the results are compared with the observed emission spectrum using distribution functions qualitatively similar to the experimental distribution $f(P_{||},P_{\perp})$. In the case of the emission above $2\Omega_c$ the theory predicts that the most unstable frequencies occur with a deviation $\delta_2 = (\omega - 2\Omega_c/2\Omega_c)$ of about 1% which is in quantitative agreement with the observed emission peak. Although in the case of the upper hybrid emission the experimental knowledge of $f(P_{||},P_{\perp})$ is insufficient to be able to make quantitative predictions about the frequency dependence of the growth rate, it is possible to obtain qualitative features of the observed emission spectrum from such a model. (Disser. Abstr.)

50179 KINETIC THEORY OF STABLE AND WEAKLY UNSTABLE PLASMA. Rogister, Andre L. Princeton, N. J., Princeton Univ., 1968. 112p.

Thesis.

Within the framework of the Klimontovich formalism, a kinetic theory is presented of spatially homogeneous plasma in which discreteness effects and collective behavior are treated on a par. The theory is thus no longer Markoffian in the one-particle distribution functions $F^{(1)}$ alone, but is in the pair $\{F^{(1)},I_k\}$ (with I_k the fluctuation spectrum of the waves). It is also the first systematic theory which applies to those regimes which are dominated by collisional absorption of the waves and/or emission by wave–particle and particle–particle scattering (bremsstrahlung). With the introduction of original contour deformations, the equations also provide the continuous transition from instability to stability, so that an initially weakly unstable plasma can be followed all the way to thermal equilibrium. The plasma is described microscopically via a phase-space density N which satisfies the nonlinear Vlasov equations with singular initial conditions reflecting the discreteness of the plasma particles. Since weakly turbulent and stable plasma are characterized by the existence of an expansion parameter $\lambda \ll 1$ which scales the size of the fluctuations, one is able to obtain the iterative solution of the nonlinear Vlasov equations. We then improve in a systematic fashion the equation for the time evolution of the fluctuation spectrum of the waves. This equation now includes all the processes of decay which are relevant in plasma (if one excludes full turbulence): linear and nonlinear Landau damping and collisional damping of the waves. One further obtains the dominant mechanisms of emission: by Cherenkov radiation, particle–particle scattering (bremsstrahlung), wave–wave scattering and wave–particle scattering. It is demonstrated also how the theory synchronizes itself to higher order in the expansion, and how the Markoffian behavior is preserved. The appropriate modifications of the equations for the time evolution of the one-particle distribution functions to include nonlinear effects are discussed. The test-particle problem is generalized to describe both unstable and stable plasma. The calculation of the coefficient of spatial diffusion across a uniform magnetic field is reviewed. (Disser. Abstr.)

50180 KINETIC THEORY OF THE CLASSICAL EQUILIBRIUM PLASMA MEDIUM. Tappert, Frederick Drach. Princeton, N. J., Princeton Univ., 1967. 214p.

Thesis.

The methods of kinetic theory are used to study a classical, Hamiltonian system consisting of N electrons (point charges) imbedded in a uniform neutralizing background of positive charge in the bulk limit ($N \to \infty$, $V \to \infty$, $n = N/V = \text{const.}$), assuming that the plasma expansion parameter ϵ is small. First, the static properties of the equilibrium plasma medium are investigated on the basis of the Gibbs canonical distribution and the BBGKY hierarchy equations for the correlation functions. Secondly, the dynamic properties of the equilibrium plasma are investigated by examining the response of the medium to a test electron which is constrained to move with constant velocity. The relevant hierarchy equations are derived and the time-dependent solutions are studied in order to obtain information regarding the relaxation process which describes the evolution of the shielding cloud and related phenomena. In a special calculation, the "one-velocity" approximation is introduced and a complete, explicit solution of the time-dependent test particle problem is obtained by using the Green function of the Klein–Gordon equation. With regard to the steady state which is eventually established, the following noteworthy results are obtained: a) general relations are found between the equilibrium correlation functions and quantities referring to the polarized state of the medium surrounding a zero-velocity test particle; b) completely convergent expressions for the mean and mean square force acting on the test particle are obtained and are evaluated for both large and small velocities; c) the induced currents, energy densities, and energy fluxes are calculated in several limiting cases; d) the effect of collisional damping on the structure of the Cherenkov wake is quantitatively examined; e) it is shown that the shielded potential has the form of a velocity dependent quadrupole interaction at large distance and the quadrupole moment is computed; f) a general proof is given that the total charge in the shielding cloud is equal and opposite to the charge of the test particle to all orders in ϵ and for all velocities. Finally, the Kubo linear response formalism is applied to the plasma test particle problem and the results are compared and contrasted to the kinetic theory results. (TSS) (Disser. Abstr.)

50181 STRUCTURE OF STRONG IONIZING SHOCK WAVES IN THE PRESENCE OF ELECTROMAGNETIC FIELDS. Molander, Roger Carl. Berkeley, Calif., Univ. of California, 1967. 88p.

Thesis.

A physical model is formulated to describe the changes taking place within the structure of a strong ionizing shock wave in the presence of electromagnetic fields. The model assumed is composed of a strong adiabatic shock to translational equilibrium followed by initiation of ionization and interaction between the flow and the electromagnetic fields. Eventually recombination causes the flow to relax to a downstream state of thermodynamic equilibrium and zero current flow. Mathematical equations are derived to describe the changes in flow parameters and electromagnetic fields within the nonequilibrium current-carrying region. Such an analysis removes the indeterminacy in the solution of the shock jump conditions which arises because of the inability to fix the upstream electric field for ionizing shock waves. Equations are derived for an arbitrary gas and arbitrary upstream magnetic field configuration. The particular case of switchon shock waves in argon is then considered in detail. Solutions are sought for shock velocity, electric field, density ratio, and downstream Mach number as a function of the upstream conditions and B_{Z4}, the switchon transverse magnetic field component. Various upstream magnetic fields and pressures are considered. The existence of a downstream saddle point requires that the integration of the governing equations proceed upstream from the downstream state. This in turn necessitates a trial and error analysis which is readily performed by guesses at the shock velocity or the downstream density. Two solutions are found for each value of B_{Z4} and these are discussed with reference to experiments taking place in an electromagnetic shock tube and the predictions of the modified Chapman–Jouguet hypothesis of Kunkel and Gross. In general one of the solutions yields a subsonic downstream state while the other is nearly sonic or slightly supersonic. The latter solution is of particular interest in view of the Chapman–Jouguet prediction of sonic conditions downstream. Brief consideration is also given to the case of transverse shock waves in argon. It is found that very little current is carried within the shock front and the structure is essentially the same as that of a conventional gas dynamic shock front propagating at the same velocity. (Disser. Abstr.)

50182 EXPERIMENTAL INVESTIGATION ON PLASMA OSCILLATIONS. Bhagavat, G. K.; Dhir, G. S. J. Inst. Telecommun. Eng., 12: 490-5(1966).

Experimental investigations have been made on longitudinal oscillations of plasma electrons in both cold-cathode and hot-cathode low-pressure discharges in Ar gas. In cold-cathode discharges no definite oscillations indicative of a fixed frequency could be picked up, instead a disturbance of constant deflection in the lecher-detector circuit was picked up and this perhaps could be attributed to some sort of noise phenomena. In hot-cathode low-pressure discharges in Ar, with bright emitting tungsten-filament, definite localized oscillations were picked up. Frequency-pulling effects were observed by the probe near the cathode as the probe distance from the cathode is varied for a fixed anode–cathode distance. Similar frequency-pulling effects were observed by the anode itself for small anode–cathode distances. (Indian Sci. Abstr.)

50183 PROPAGATION OF MICROWAVES IN A PLASMA CABLE. Bhagavat, G. K. J. Inst. Telecommun. Eng., 12: 450-6(1966).

The dielectric properties of plasma are discussed. The propagation conditions for electromagnetic waves in a plasma cable are obtained. An experimental verification of the propagation at 3 cm is described. (Indian Sci. Abstr.)

50184 SCATTERING OF PARTICLE BEAMS FROM PLASMAS. Goldstein, Byron B. New York, New York Univ., 1967. 151p.

Thesis.

The probability of detecting collective effects in laboratory

plasmas by the use of atomic beam scattering experiments is investigated. It is found that the scattering of light atoms from dense plasmas, composed of electrons and heavy ions, offers the best possibility for the detection of such effects. In the impulse approximation, the differential cross section ($d\sigma/d\Omega$) for scattering of spin-½ atoms from a plasma is obtained. Certain further approximations are made which greatly simplify the form of ($d\sigma/d\Omega$), with the result that ($d\sigma/d\Omega$) is given in terms of the atom–ion and atom–electron two-body scattering amplitudes and in terms of integrals over the dynamic form factors of the plasma. For the coherent form factors for a classical plasma, the results of Ichimaru, corrected to include the recoil energy of the electrons are used. The electron incoherent dynamic form factor is obtained from the electron coherent dynamic form factor by use of the convolution approximation. ($d\sigma/d\Omega$) is calculated for a 1-eV Li beam scattering from a Cs plasma with an ion and electron temperature of 1 eV and with a density equal to 10^{16} cm^{-3}. The Li–Cs^+ scattering amplitude is obtained from a semiclassical approximation. The Li–e^- scattering amplitude is obtained from phase shifts reported in the literature. We find that for $\theta > 1 \times 10^{-2}$ the contributions to ($d\sigma/d\Omega$) due to electron scattering will be negligible. For $\theta \lesssim 5 \times 10^{-5}$ collective effects become important. Further it is found that, in general ($d\sigma/d\Omega$) can be expressed in terms of the ion and ion–electron static form factors $S_{+}(k)$ and $S_{+-}(k)$ plus integrals over the electron coherent and incoherent dynamic form factors. Finally one concludes that the convolution approximation used to calculate the electron incoherent dynamic form factor leads directly to the prediction that the spin-flip cross section will be enhanced as θ goes to zero. (Disser. Abstr.)

50185 THE EFFECTS OF A TEMPERATURE DEPENDENT THERMAL DIFFUSIVITY AND RADIATION LOSS ON ARC COLUMN DECAY. Holmes, R.; Jones, G. R. (Univ. of Liverpool). Z. Phys., 215: 466-80(1968).

Numerical computations of the free recovery of arc columns in air and nitrogen are presented. In addition to thermal conduction radiation losses are taken into account and the influence of a temperature dependent thermal diffusivity is considered. At short times after interruption a high thermal diffusivity in the core accelerates the conductance decay while at later times the rate of recovery is reduced due to a small diffusivity in the outer regions of the column. For high current arcs radiation is an important loss mechanism immediately after an interruption. (auth)

50186 FLUIDLIKE ELECTRON AND ION MODES IN INHOMOGENEOUS PLASMAS. Coppi, B.; Rosenbluth, M.; Rutherford, P. (Princeton Univ., N. J.). Contract AT(30-1)-1238. Phys. Rev. Lett., 21: 1055-9(Oct. 7, 1968).

Collisionless unstable modes, involving the entire velocity space and not due to Landau damping effects, are shown to exist in two-dimensional configurations in which the particle orbits are periodic along the magnetic field lines, where the magnetic intensity varies along the field, and the particle density gradient is in a perpendicular direction. One mode is associated with the velocity dependence of the electron excursion frequency and one with the trapping of ions in the magnetic field wells. Their relevance to laboratory and space plasmas is pointed out. (auth)

50187 LABORATORY OBSERVATIONS OF PLASMA SATELLITES ON THE 2^1P–4^1D AND 2^3P–4^3D LINES OF HELIUM. Kunze, H.-J.; Griem, Hans R. (Univ. of Maryland, College Park). Phys. Rev. Lett., 21: 1048-52(Oct. 7, 1968).

During the implosion phase of a low-density θ pinch in helium preheated to $T_e \approx 1$ eV at $N_e \approx 5 \times 10^{13}$ cm^{-3}, the He I 2^1P–4^1D and 2^3P–4^3D lines show satellites displaced away from the forbidden 2P–nF transitions by 0.3 to 0.6 Å. These satellites are identified with those predicted by Baranger and Mozer as due to the effects of nonthermal longitudinal plasma oscillations on atomic spectra. (auth)

50188 EXPERIMENTAL TEST OF H_β STARK-BROADENING THEORY AT HIGH ELECTRON DENSITIES. Shumaker, J. B. Jr.; Popenoe, C. H. (National Bureau of Standards, Washington, D. C.). Phys. Rev. Lett., 21: 1046–8(Oct. 7, 1968).

H_β spectral-line profiles produced in atmospheric-pressure high-current arc experiments at the Fowler–Milne normal electron density are compared with theory and found to agree within the approximately 10% uncertainty of the theory under these conditions. (auth)

50189 EXPERIMENTAL TEST OF H_β STARK-BROADENING THEORY AT HIGH ELECTRON DENSITIES. Morris, J. C.; Krey, R. U. (Avco Corp., Wilmington, Mass.). Phys. Rev. Lett., 21: 1043-5(Oct. 7, 1968). Contract AF33(615)-2976.

The profile of hydrogen beta has been measured for a temperature of 16,700°K and an electron number density of 2×10^{17} cm^{-3} using an arc-generated plasma. These data are compared with theory on area normalization and half-width bases and found to agree with theory within the accuracy quoted for theory. (auth)

50190 ELECTRODE EROSION OF PULSED PLASMA ACCELERATORS. I. ANODE. Mokshantsev, B. B.; Tikhonov, V. B. Izv. Vyssh. Ucheb. Zaved., Fiz., No. 6, 46-51(1968). (In Russian).

In contrast to ordinary vacuum discharge (electric spark metal processing, light pulse sources, etc.) in the intra-electrode gap of pulsed plasma accelerators, an electromagnetic acceleration of the discharge column reaching 10^6 to 10^7 cm/sec^2 and over takes place. The acceleration inhibits the formation of pre-electrode areas and initiates electrode erosion. Studies were made of the properties of anode erosion and development of anodic spots in pulsed accelerators. Data obtained showed for aluminum, copper, and molybdenum the magnitude of anode errosion was 3×10^{-5}, 0.6×10^{-5}, and 0.5×10^{-5} g/k, respectively. (R.V.J.)

50191 ELECTRODE EROSION OF PULSED PLASMA ACCELERATORS. II. CATHODE. Mokshantsev, B. B.; Tikhonov, V. B. Izv. Vyssh. Ucheb. Zaved., Fiz., No. 6, 52-8(1968). (In Russian).

Properties of cathode surface erosion and dynamics of cathode spots in pulsed accelerators of track geometry were studied using massive copper and aluminum cathodes and metallized glass electrodes with 1500-Å to 10-μ-thick coatings. The aluminum and copper coating was accomplished by thermal blowing in a vacuum at 10^{-5}-mm Hg pressure. It was found that high current density in a cathode microspot caused damage to the cathode surface within 10^{-8} sec which resembled explosion of small wires by a high current density. Under the above conditions the microspots moved in the opposite direction to the plasma motion. The cathode tracks were distributed in relation to the various types of inhomogeneities on the surface. The erosion magnitude for copper and aluminum electrodes was found to be 0.7×10^{-5} and 1.5×10^{-5} g/k, respectively. (R.V.J.)

50192 EQUILIBRIUM AND STABILITY OF A HIGH-CURRENT DISCHARGE IN A DENSE PLASMA UNDER CONDITIONS OF RADIANT HEAT CONDUCTION. Rukhadze, A. A.; Triger, S. A. Zh. Prikl. Mekh. Tekh. Fiz., No. 3, 11-18(May-June 1968). (In Russian).

A total set of magnetohydrodynamic equations describes a plasma with the radiant heat conduction being taken into account. At high temperatures (T ≈ 3 to 10 eV) the plasma can be considered as a completely ionized ideal gas. The electron heat conduction is neglected compared to the radiant heat conduction. Under equilibrium discharge conditions the electric field E_0 is homogeneous along the plasma cross section. The pressure, density, plasma temperature, current and magnetic field are then functions of the space coordinates. Under conditions of high heat conduction the plasma temperature is uniform over the discharge cross section, while the density and pressure decrease rapidly as distance from the discharge axis increases. An analysis of the spectra of small oscillations showed that the equilibrium discharge at low plasma conductivity was unstable with respect to short-wavelength hydrodynamic oscillations (bending, necking). The development of instabilities is possible only for long-wavelength perturbations in a cylindrical discharge, and also in a nonequilibrium discharge under conditions where the rise time of the instabilities is less than the time of establishing equilibrium. A plane, equilibrium discharge turns out to be stable. A cylindrical equilibrium discharge in a plane, low-temperature plasma is more stable than a discharge in a high-temperature plasma. (TTT)

50193 LAMINAR CONDUCTIVITY EFFECT IN A WELL MAGNETIZED PLASMA. Morozov, A. I. Zh. Prikl. Mekh. Tekh. Fiz., No. 3, 19-22(May-June 1968). (In Russian).

An electron drifting in crossed electric and magnetic fields acquires a transverse velocity component $\omega = cE/H$. On colliding with the wall the electron loses its velocity, and a current flows along the E field. Reflection from the Debye layer usually takes place rather than direct interaction of the electron with the wall. The probability for the appearance of a reflected particle with velocity v′ after striking a point with velocity v is determined. A Maxwellian velocity distribution is assumed for the incident particles. The magnetic field is assumed to be perpendicular to the wall, while the electric field is parallel to the wall. The distribution of current density near the wall, as expected, was found to be concentrated in a thin laminar layer. (TTT)

50194 PRIMARY AND SECONDARY PROCESSES DURING FORMATION OF A DISCHARGE OVER A SHORT, GASEOUS PATH LENGTH AT NANOSECOND INTERVALS OF TIME. Mesyats, G. A.; Iskol'dskii, A. M.; Kremnev, V. V.; Bychkova, L. G.; Bychkov, Yu. I. Zh. Prikl. Mekh. Tekh. Fiz., No. 3, 77-81(May-June 1968). (In Russian).

An electron appearing at the cathode leads to the development of an electron avalanche. In high fields a large number of electrons are formed in the avalanche over a length much smaller than the discharge length. When the number of electrons in the avalanche attains a definite value, the intrinsic field of the ions and electrons themselves begins to have an effect on the behavior of the avalanche. The ion field will slow down the tail of an electron avalanche, while the electron field will tend to accelerate the electrons at the head, that is, the electrons in the avalanche will tend to disperse. It is shown that this effect begins to appear even during the exponential growth of an avalanche. At the beginning of an avalanche slowdown, more than 10% of the electrons are moving at a velocity greater than the electron drift velocity, and the remainder of the electrons are below this velocity. When the ion field is equal to the external field, the electron head separates from the avalanche, and begins to form a new avalanche. This new avalanche throws out another, smaller portion of electrons. The total number of electrons in such an avalanche chain is estimated. Secondary emission processes are discussed. (TTT)

Production of Plasma

50195 CONTINUOUS SUPERSONIC PLASMA WIND TUNNEL. Andersen, S. A. (Research Establishment Risoe, Roskilde, Denmark); Jensen, V. O.; Nielsen, P.; D'Angelo, N. Phys. Lett., 27A: 527-8(Sept. 9, 1968).

The B-field configuration of a Q device has been modified into a magnetic Laval nozzle. Continuous supersonic plasma flow is observed with $M \approx 3$. (auth)

50196 PLASMAS PRODUCED BY FOCUSED CO_2 LASER RADIATION. Gibson, A. F. (Univ. of Essex, Eng.); Hughes, T. P.; Kimmitt, M. F.; Hallin, R. Phys. Lett., 27A: 470-1 (Sept. 9, 1968).

The spectra of multiply ionized atoms have been recorded from plasmas produced by focusing 0.35-MW Q-switched pulses from a CO_2 laser on to solid targets. (auth)

50197 CALCULATING THE STATE OF ARGON BEHIND AN INCIDENT STOCK WAVE AT MACH NUMBERS FROM 20 TO 50 WITH EXCITATION, MULTIPLE IONIZATION, AND COULOMB INTERACTION BEING TAKEN INTO ACCOUNT. Kozlov, G. I.; Stupitskii, E. L. Zh. Prikl. Mekh. Tekh. Fiz., No. 3, 94-7(May-June 1968). (In Russian).

The plasma parameters behind the incident shock wave are related by writing equations for the conservation of mass, momentum and energy, for the mass action law, for the state of the gas with the Coulombic interaction being taken into account, and for the enthalpy of a monatomic gas. Equilibrium constants for single, double, and triple ionization with excitation of electronic levels and lowering of ionization potentials because of Coulombic interaction being taken into account were determined by formulas of statistical thermodynamics. The equations were solved by successive approximations on a computer for initial pressures of 0.1, 0.3, 1.0, 3.0, 10, 25, 50, and 100 mm Hg std. The temperature, compression, and degree of ionization behind the shock wave front is plotted as a function of Mach number M at pressures of 0.1-, 1.0-, 10- and 100-mm Hg std. The ratio of excitation energy to gas enthalpy is also plotted as a function of Mach number for initial pressures of 1-, 10-, and 100-mm Hg std. At high Mach numbers and pressures the electron excitation energy must be taken into account in determining the state of a gas. The adiabatic exponent γ was calculated and was found to change only slightly within the interval of Mach numbers from 25 to 50. (TTT)

50198 EXPERIMENTS ON NEUTRON OBSERVATION BY FOCUSING POWERFUL LASER EMISSION ON THE SURFACE OF LITHIUM DEUTERIDE. Basov, N. G.; Zakharov, S. D.; Kryukov, P. G.; Senatskii, Yu. V.; Chekalin, S. V. (Lebedev Inst. of Physics, Moscow). JETP Lett. (USSR)(Engl. Transl.), 8: 14-17(July 1968).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma, Redaktsiyu, 8: 26-30(July 5, 1968).

The results of preliminary investigations aimed at obtaining thermonuclear temperatures in a dense plasma with the aid of powerful laser emission are reported. (M.H.R.)

50199 SIMULTANEOUS COMBUSTION OF HIGH-CURRENT AND HIGH-FREQUENCY ARCS IN A PLASMATRON. Bogatyreva, V. A.; Vorob'eva, N. I.; Zhukov, M. F.; Sukhinin, Yu. I. Zh. Prikl. Mekh. Tekh. Fiz., No. 3, 86-9(May-June 1968). (In Russian).

In existing low-temperature plasma generators, which use an electric arc of variable current as the thermal energy source, an inductance must be included in the feed circuit in order to maintain a continuous arc. In this case the power factor ($\cos \phi$) does not exceed 0.6 to 0.7. It is possible to maintain a continuous arc with circuit inductance and to obtain a sinusoidal change in voltage under certain conditions by maintaining a high-voltage, low-current arc in addition to the high-current arc. The high-voltage discharge opens up an electrically conducting channel along which the high-current discharge is maintained by vortex stabilization. A diagram of the circuit is given. The high-current arc discharge showed a power of 52 kW (voltage = 217 volts) with a power of only 0.75 kW in the high-frequency arc with good agreement between the measured and calculated values. Preliminary experiments showed that in plasmatrons with vortical, argon stabilization a change in power of the high-frequency arc from 2 to 4 kW increased the arc current from 240 to 2500 amps (gas flow of 110 g/sec). (TTT)

Stability of Plasma

50200 (IPP-1/77) ON THE DYNAMIC STABILIZATION OF A Z-PINCH. Andelfinger, C.; Lehner, G. (Institut fuer Plasmaphysik, G.m.b.H., Garching (West Germany)). Mar. 1968. 17p. Dep.

An experiment is described in which a linear Z pinch is stabilized by means of a superimposed high frequency theta pinch. Stability is obtained more easily than would be expected from Weibel's criteria. Future plans for using this method to build a dynamically stabilized screw pinch are discussed. (auth)

50201 (JINR-P9-3981) NONLINEAR DRIFT INSTABILITY IN TURBULENT PLASMA. Krivorutskii, E. N.; Makhan'kov, V. G.; Tsytovich, V. N. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Computing Techniques and Automation). 1968. 8p. (In Russian). Dep.

It is shown that high-frequency plasma turbulence imposes a significant influence on the spectrum and buildup (damping) of drift oscillations. It is emphasized that even at very weak high-frequency amplitudes $W/n_0T_e \ll 1$, a considerable change in spectrum drift oscillations could be expected. (R.V.J.)

50202 STABILISATION OF THE SCREW-TYPE INSTABILITY BY AN HF FIELD. Artsimovich, L. L. (Kurchatov Inst. of Atomic Energy, Moscow); Ivanov, A. A.; Rusanov, V. D.; Sobolev, S. S.; Teichmann, J. Phys. Lett., 27A: 573-4(Sept. 9, 1968).

The stabilizing effect of a hf electromagnetic field has been studied in the case of a screw-type instability. It is shown experimentally that according to the theory a decrease in amplitude of the oscillations and radial diffusion takes place. (auth)

50203 PLASMA STABILITY IN MAGNETIC TRAPS. II. MICROSTABILITY THEORY. Jukes, J. D. (Culham Lab., Abingdon, Eng.). Rep. Progr. Phys., 37: 315-39(1968).

Plasma confined within magnetic traps can be stabilized according to idealized magnetohydrodynamic theories. Inclusion of real-particle effects, however, introduces a new and wide range of microinstabilities, even when collisions are ignored. These are small-scale instabilities which can grow at the expense of the free energy available in the particles distribution function in velocity space. This energy is present by virtue of anisotropy in velocity distribution, or spatial inhomogeneity in density and temperature. Although it becomes apparent that absolute stabilization is difficult to achieve, there are certain parameters available in the design of traps to limit the growth rates and therefore the severity of most micro-instabilities. These are examined quantitatively. When a microinstability grows beyond a linear limit a weak micro-turbulence occurs, which causes anomalous diffusion. The resulting loss of plasma may remain tolerable. A brief account of weak turbulence, and a phenomenological description of possible strong turbulence effects, are given. (auth) (UK)

50204 STABILIZATION OF THE INSTABILITIES OF "CLOSED" PARTICLES IN A DENSE PLASMA. Sagdeev, R. Z.; Galeev, A. A. Dokl. Akad. Nauk SSSR, 180: 839-42(June 1, 1968). (In Russian).

Consideration of "closed" particles in the kinetic theory of the stability of plasma in toroidal magnetic traps lead to the discovery of low-frequency instabilities, generated after several instability periods of closed particles between local magnetic plugs. Intersection of the lines of force of the magnetic field (shear) does not prevent the development of the instability. It is shown that in a sufficiently dense plasma, in the case of high-frequency electron–ion collisions, the drift-dissipative instability increment of closed particles decreases. In this case, the Landau damping is capable of stabilizing the instability. An axially symmetric magnetic field was used for the calculations which were based on the authors' previously described low-pressure equilibrium plasma. An equa-

tion was derived to take into account the resonance interaction of flying ions with slow oscillations. It was found that Landau damping exerts a very slight stabilizing effect on long-wave oscillations; however, they are suppressed by weak collisions of closed ions. (TTT)

50205 POTENTIAL STABILIZATION OF THE FLUTE INSTABILITY OF PLASMA BY MEANS OF A FEEDBACK SYSTEM. Arsenin, V. V.; Chuyanov, V. A. Dokl. Akad. Nauk SSSR, 180: 1078-80(June 11, 1968). (In Russian).

In adiabatic traps with axially decreasing magnetic field, the high density plasma is unstable with respect to flute instabilities which extend along the lines of force of the magnetic field. This instability is created by the charge separation in the perturbed portion, resulting from the differential azimuthal drift velocities of electrons and ions in an inhomogeneous field. A specific case was examined involving a surface between the plasma and the walls of the chamber. The potential of this surface was kept at the same level as that of the plasma. Under certain conditions, the drift of the plasma decreases the initial perturbation, that is, the plasma becomes stabilized. The study involved the stability of an infinite cylinder of verified inhomogeneous plasma in the absence of a dc electric field without considering the finiteness of the Larmor radius of the ions. The equation for flute oscillations indicated that if the plasma density exhibits a parabolic distribution in the radial direction, the conditions of stabilization coincide with a previously derived equation. Such a stabilization by a feedback system has been examined previously in the hydrodynamic approximation. (TTT)

50206 EXPERIMENTAL INVESTIGATION OF PLASMA DRIFT INSTABILITY IN AN EXTERNAL HIGH-FREQUENCY FIELD. Izmailov, A. N.; Fainberg, Ya. B.; Chechel, V. K.; Shapiro, V. D. (Inst. of Physics and Tech., Kharkov). Ukr. Fiz. Zh., 13: 1215-19(July 1968). (In Russian).

The suppression of drift instability of the potassium plasma produced by contact ionization in an external hf field is considered. It is shown that the drift instability suppression is caused by a longitudinal component of the external hf electric field. The stabilization of the drift instability is accompanied by decreasing plasma diffusion towards the vessel walls. (auth)

50207 ON THE INFLUENCE OF THE VOLUME CHARGE ON THE STABILITY OF A PLASMA COLUMN WITH FREE BOUNDARY. Vardanyan, V. A. (Erevan State Univ.). Izv. Akad. Nauk Arm. SSR, Ser. Fiz., 2: 404-14(1967). (In Russian).

The influence of the diffusion distribution of the volume charge on the stability of a cylindrical plasma column with respect to perturbations that tend to change the geometrical form of the column surface is considered. It is shown that the ambipolar distribution does not influence the stability of this form of long plasma column. Criteria for the column stability, when the charge distribution corresponds to the intermediate case between the ordinary and the ambipolar diffusion, are obtained. It is also shown that the presence of such a charge establishes a relation between the stability and the radius of the active zone. Moreover, very thin streams caused by the powerful source are extremely unstable. (auth)

50208 SHEAR STABILIZATION OF A COLLISION-DOMINATED PLASMA. Reynolds, J. F.; Holt, E. H. (Rensselaer Polytechnic Inst., Troy, N. Y.). Phys. Rev., 175: 205-17(Nov. 5, 1968).

The effect of magnetic shear on the stability of the electron–neutral collision-dominated plasma is determined by introducing the shear directly into the basic macroscopic equations which describe the plasma. The dispersion equation for the family of perturbations of helical form is reduced to a stability criterion which defines the onset of such perturbations. An equation describing the form of the zero-order plasma density profile, which is required for the numerical evaluation of the stability criterion, is derived. The theory is applied to a hollow plasma column. Theoretical radial profiles of the zero-order plasma density are computed and verified experimentally. The experimentally determined profile of the first-order plasma density guides the choice of the mathematical model of the perturbation which is used in the stability calculation. The hollow plasma column is found experimentally to possess a regime between the quiescent and turbulent states where perturbations of helical form exist. Mode switching between the single and double helical perturbances is found. The plasma is predicted to be stabilized when the magnetic shear is in the opposite sense to the plasma perturbation, and destabilized in the other case. These predictions are experimentally verified within the overall accuracy of experiment and theory. (auth)

50209 STABILITY OF THE GUIDING-CENTER PLASMA. Nelson, David Brian. New York, New York Univ., 1967. 45p. Thesis.

Using a variational principal for the guiding-center plasma, the implications for absolute stability of local stability plus interchange stability are examined. The geometry chosen for this analysis is open-ended, with magnetic lines free to interchange at the ends. The method of analysis uses the fact that any admissible variation away from an equilibrium can be decomposed into an interchange plus a variation which vanishes at one end of the plasma domain. Then the second variation, as a quadratic form, is accordingly separated into three terms which are examined separately. It is found that if the spatial magnetic field and plasma gradients are sufficiently small, then local stability plus a strong form of interchange stability do suffice for absolute variational stability. This strong form is actually weaker than most of the sufficient conditions for interchange stability which have previously been derived. It is shown that lengthening a stable plasma does not result in instability, whether or not the ends are tied. (Disser. Abstr.)

50210 DRIFT INSTABILITY IN A DILUTE AND IN A DENSE PLASMA. Buchel'nikova, N. S.; Salimov, R. A.; Eidel'man, Yu. I. Zh. Prikl. Mekh. Tekh. Fiz., No, 3, 89-93(May-June 1968). (In Russian).

Experiments were carried on in a unit in which a plasma is formed by thermal ionization of potassium metal on a tungsten surface of radius R = 2 cm, heated to 2000°K. The length of the plasma column was L = 36 cm. The experiments were performed at plasma densities $n = 3 \times 10^8$ to 5×10^{11} cm^{-3}, and at magnetic fields of 600 to 3000 Oe. It was found that the amplitude of the oscillations and the diffusion coefficient did not depend on the plasma density. The type of diffusion and the dependence of the diffusion coefficient on magnetic field strength H are the same in a dilute and in a dense plasma. Diffusion is of a classical type in the absence of instability. It is shown that dampening of instability harmonics with increasing magnetic field can be explained by a spread of perturbations because of drift in a system with a cold face on one end. Dampening of the second harmonic with decreasing magnetic field is apparently determined by stabilization of the instability because of ion–ion collisions. (TTT)

50211 INSTABILITIES DUE TO MAGNETIC FIELD SPATIAL VARIATIONS. Clarke, J. F.; Kelley, G. G. (Oak Ridge National Lab., Tenn.). Phys. Rev. Lett., 21: 1041-3(Oct. 7, 1968).

A departure from the usual assumption of a uniform magnetic field in the calculation of the Harris dispersion relation is shown to lead to new velocity–space instability. If the magnetic field variations are small and if a particle transit time through a complete cycle of the field is less than the instability growth time, an average (velocity-dependent) gyrofrequency may be assumed which leads to negative-mass-type instabilities. (auth)

Thermonuclear Processes

50212 (IPP-1/83) MEASUREMENT OF NEUTRON SPECTRA FOR DETERMINING THE DEUTERON VELOCITY DISTRIBUTION IN A LINEAR THETA PINCH. Paretzke, H. (Institut fuer Plasmaphysik, G.m.b.H., Garching (West Germany)). May 1968. 65p. (In German). Dep.

A hot deuterium plasma emits fast neutrons from the reaction $D(d,n)^3He$. Their energy spectra measured in qualified directions can give information about the velocity distribution of the reacting deuterons. This is due to the spatial anisotropy of the neutron energy at the reaction resulting from a kind of Doppler effect. The neutron energy spectra were measured here with nuclear emulsion plates side-on, i.e., vertically to the axis, and end-on, i.e., on the axis of the coil, in the ISAR-I theta-pinch experiment. These spectra were used for obtaining details about the strongly anisotropic velocity distribution of the deuterons. The end-on spectrum reflects the apparatus profile of the emulsion plates. This means that the mean energy of Maxwell distributed deuterons parallel to the axis was smaller than about 1 keV. The side-on spectrum has a f.w.h.m. of 180 ± 30 keV. A comparison was made to check the consistency of the side-on energy spectrum and the value of $\langle \sigma v \rangle$ determined by measuring the neutron flux and ion density. This strongly suggests the existence of a generalized Maxwell distribution at a temperature of $T_\perp = 4.5 \pm 1$ keV at the plane vertical to the axis. Monoenergetic distributions can be safely excluded. (auth)

Shielding

Refer also to abstracts 48983, 50502, and 50510.

50213 (EUR-3913) SHIELDING EXPERIMENTS AT THE REACTOR STATION GEESTHACHT. Annual Report, 1966. Bagge, E.; Fischer, E. (Gesellschaft fuer fuer Kernenergie-

verwertung in Schiffbau und Schiffahrt m.b.H., Hamburg (West Germany)). 1968. 210p. (In German). Dep.

Under the terms of a treaty concluded between EURATOM and the Gesellschaft für Kernenergieverwertung in Schiffbau und Schiffahrt (GKSS), further studies were carried out on radiation behavior in shielding at Geesthacht reactor center. The experimental work was carried out on the FRG-1 and FRG-2 research reactors, mainly with the aid of the ESTAKOS and ESTAGROP experimental facilities. The work also included the determination of radiation intensity in laminated shields as well as measurements of the neutron flux in cylindrical tubes. In addition, work was begun on the development of measuring devices and detectors for neutron and gamma radiation. The theoretical work is concerned with the calculation of neutron spectra in shielding, studies of the possibility of extending the RESTRAB program set, comparative calculations for use in conjunction with experimental results obtained with this program, as well as the further development of shield optimization methods. (auth)

50214 (ORNL-4289(Vol.2)) TIME-DEPENDENT NEUTRON AND SECONDARY GAMMA-RAY TRANSPORT IN AN AIR-OVER-GROUND GEOMETRY. VOLUME II. TABULATED DATA. Straker, E. A. (Oak Ridge National Lab., Tenn.). Sept. 1968. Contract W-7405-eng-26. 529p. Dep. CFSTI.

The tabulated results of Monte Carlo and discrete ordinates calculations of neutron fluxes and doses and secondary gamma-ray fluxes and doses resulting from an isotropic neutron source located 50 ft above the ground surface are presented. Sources of various energies up to 15 MeV are considered, and in addition the sources are folded together to simulate a fission source. The Monte Carlo data are tabulated as time-energy and time-dose distributions integrated over angle and as time-angle distributions integrated over energy for ranges from the source up to approximately 1500 meters. The discrete ordinates data are tabulated as energy spectra and as angular dose at the various ranges, and also as angular distributions of the thermal, intermediate, fast, and total neutron flux and of the low, high, and total gamma-ray flux. (auth)

50215 THE SHIELDING OF γ RADIATION BY ORDINARY CONCRETE. Krueger, F. W. (VEB Kernkraftwerksbau, Berlin). Kernenergie, 11: 197-203(July 1968). (In German).

The chemical composition of ordinary concretes may be very different. The effect of such differences on the attenuation of gamma radiation is studied. It is shown that different compositions cause only small changes in shielding efficiency. Therefore, in designing an ordinary concrete shield the particular chemical composition may be ignored, and it is permissible to use an averaged attenuation function. This attenuation function is given. It was used for the estimation of tables for the shielding of gamma radiation by ordinary concrete. (auth)

50216 GAMMA RAY PENETRATION THROUGH AND BACK SCATTERING FROM CONCRETE SLABS. Su, Yung Sung; Wu, Kuh Chou (National Tsing Hua Univ., Taiwan). Energ. Nucl. (Milan), 15: 654-60(Oct. 1968).

The differential angular energy spectra of plane parallel gamma radiation transmitted through and backscattered from the surface of concrete slabs were measured by a NaI(Tl) scintillation detector with a 400-channel pulse-height analyzer. Some general features of the angular energy spectrum are revealed. Transmitted scattered energy spectra, transmitted scattered angular distributions, and transmitted dose rate ratios obtained from experimental results are compared with the results of a Monte Carlo calculation. (auth)

50217 MULTIPLE SCATTERING AND THE INVERSE ALBEDO PROBLEM. Pahor, S. (Univ. of Michigan, Ann Arbor). Phys. Rev., 175: 218-21(Nov. 5, 1968).

The inverse thin-slab albedo problem, or how to determine the scattering function from the measured reflected and transmitted distributions, is considered. It is shown that the scattering function can be determined from the reflected and/or transmitted distributions, measured in certain directions, without using any theoretical model for the scattering kernel. The method, in fact, provides for a measurement of multiple-scattering contributions in the determination of the scattering kernel. An iterative procedure for computing the scattering kernel from measured distributions is described and applied to one-speed isotropic scattering. (auth)

Solid-State Physics

Refer also to abstracts 48885, 48894, 49147, and 49845.

50218 (AERE-R-5631) THE APPLICATION OF PHOTOLITHOGRAPHIC TECHNIQUES TO THE DOPING OF SEMICONDUCTORS BY ION IMPLANTATION. Osborne, D. N. (Atomic Energy Research Establishment, Harwell (England)). June 1968. 10p. Dep. CFSTI. UK 1s. 9d.

A description is given of a photolithographic process for producing etched device patterns in SiO_2 and/or metal layers on silicon, which are suitable for masking purposes in relation to the ion-implantation doping of the silicon for application in microelectronic devices. (auth) (UK)

50219 (GA-8745) AB INITIO CALCULATION OF PHONON DISPERSION CURVES FOR BERYLLIUM. Koppel, J. U. (Gulf General Atomic, Inc., San Diego, Calif.). July 1968. Contract AT(04-3)-167. 167p. Dep. CFSTI.

Thesis. Submitted to Univ. of California, San Diego.

Sham's method for calculating phonon dispersion curves in metals is generalized to nonprimitive lattices and applied to the case of beryllium which has the hexagonal closed-packed structure. Three effects contribute to the elements of the dynamical matrix which determines the phonon frequencies: (1) the direct Coulomb interaction between ions, (2) the short-range exchange repulsion between core electrons of neighboring ions, and (3) the strong screening action of the conduction electrons. The latter contribution is evaluated from a screened Hartree–Fock expression for the electronic ground-state energy in the distorted crystal. This energy is expanded up to second order in powers of the displacements of the ions from their equilibrium position. The second-order energy involves both the screened and the bare electron–phonon matrix elements which are related to each other by a dielectric screening matrix. This matrix is the essential feature of the method and accounts for the effects of the true band structure of the crystal. Numerical results are given for the beryllium band structure, dielectric matrix, and phonon dispersion curves. Energies and wave functions of the Bloch states are calculated by the orthogonalized plane waves method. (auth)

50220 (IS-T-252) NUCLEAR SPIN RELAXATION OF HYDROGEN IN THORIUM HYDRIDES. Will, Jerald Duane (Ames Lab., Iowa). Aug. 1968. Contract W-7405-eng-82. 89p. Dep. CFSTI.

Thesis.

Hydrogen nuclear spin relaxation in the two distinct thorium hydride phases (ThH_2, Th_4H_{15}) has been studied as a function of temperature in the temperature regions where hydrogen diffusion provides the dominant relaxation mechanism (173°C to 470°C for ThH_2, 78°C to 470°C for Th_4H_{15}). Pulsed nuclear magnetic resonance measurements of the hydrogen spin–lattice and spin–spin relaxation times at a resonance frequency of 10.5 MHz have been interpreted in terms of existing translational diffusion theory in order to extract diffusion parameters and mechanisms. Activation energies determined for the two ThH_2 samples studied, which have a face-centered-tetragonal metal lattice, are 18.3 kcal/mole for the hydrogen to metal ratio H/Th ~ 1.8 and 16.2 kcal/mole for H/Th ~ 2.1. For this phase the diffusion mechanism indicated by this study is that of hydrogen jumps between tetrahedral interstitial positions and nearest-neighbor octahedral interstitial positions. In ThH_2 there is evidence for an additional relaxation mechanism with a spin–lattice relaxation time given by α/T where $\alpha = 238$ seconds – °K. In addition, negative fractional shifts on the order of 10^{-4} have been determined in the hydrogen resonance frequencies at constant magnetic field. Relaxation measurements in the two Th_4H_{15} samples are complicated by the fact that the relaxation times at a particular temperature depend upon the maximum temperature to which the samples have previously been raised. The relaxation data taken for temperatures below a maximum temperature, after the samples have experienced the maximum temperature, are predicted satisfactorily by theory when it is assumed that those hydrogens in one of the two crystallographically inequivalent sites in the complex body-centered-cubic structure of this compound do not diffuse whereas those hydrogens in the other site make jumps between nearest-neighbor positions of that type. (auth)

50221 (NYO-3464-14) THE F CENTER IN CESIUM FLUORIDE: OPTICAL ABSORPTION PROPERTIES. Report No. 996. Fulton, T. A.; Fitchen, D. B. (Cornell Univ., Ithaca, N. Y. Materials Science Center). Aug. 1968. Contract AT(30-1)-3464. 63p. Dep. CFSTI.

Studies of the well-resolved triplet line shape of the F band in cesium fluoride and its temperature dependence, magnetic circular dichroism, and stress-induced behavior are reported. The results are in accord with the picture proposed by Moran, in which the triplet structure results from a combined spin–orbit coupling and Jahn–Teller effect in the excited states, although an accurate numerical calculation of the line shape predicted by his adiabatic model shows certain features not found experimentally. The circular dichroism results show that the contribution of the Γ_{12} lattice modes to the F-band second moment is ≈15%.

This relatively weak coupling, taken along with the spin–orbit stabilization of the Γ_{3g} and Γ_{15} mode interactions results in the component bands of the line shape being quite narrow. These narrow bands are comparable in width to optical phonon energies in cesium fluoride, so that discrete optical phonon transitions are observed in the F band. (auth)

50222 (ORNL–4304) TCDATA: A FORTRAN PROGRAM FOR COMPUTING THERMODYNAMIC DATA OF COMPOUNDS IN ANY PHASE STATE. Fontana, M. H. (Oak Ridge National Lab., Tenn.). Sept. 1968. Contract W-7405-eng-26. 45p. Dep. CFSTI.

A code written for the CDC 1604 in Fortran 63 may be used to compute the following thermodynamic data as a function of temperature: specific heat, entropy, free energy function, enthalpy of formation, free energy of formation, and the $\log_{10}$ of the equilibrium constant of the particular compound in question as formed from its elements in their standard state at that temperature. The format of the tabulated data is similar to that used for the JANAF thermochemical tables. A sample calculation was performed for SrO (gas) and compared with independently published data. (auth)

50223 (PRNC–115) NEUTRON DIFFRACTION PROGRAM. Progress Summary Report No. 6. Kay, M. I.; Kaplan, S. F.; Kleinberg, R.; Gonzalo, J. A.; Cromer, D. T. (Puerto Rico Nuclear Center, Mayaguez). Apr. 1968. Contract AT(40-1)-1833. 36p. Dep. CFSTI.

The neutron diffraction group worked on essentially two types of problems. The first was concerned with the chemical binding of atoms in crystals and molecules, and the second with the nature of ferromagnetism. Both problems are related to the spatial arrangement of atoms in molecules. Spiral oscillations of the sulfate group in sodium alum ($NaAl(SO_4)_2 \cdot 12\ H_2O$) were studied. The ferroelectrics sodium nitrite and sodium trihydrogen selenite were also studied. (W.D.M.)

50224 (UCRL–17877) ANGULAR CORRELATION- AND MOESSBAUER-NMR. Matthias, E. (California Univ., Berkeley. Lawrence Radiation Lab.). Oct. 1967. Contract W-7405-eng-48. 45p. (CONF-670812–18). Dep. CFSTI.

From International Conference on Hyperfine Interactions, Pacific Grove, Calif.

The general question of how to perform and detect nuclear magnetic resonance in radioactive isotopes is discussed. Gamma-ray detection of resonances in isomeric states is emphasized. The use of multipole radiation fields for detection introduces new and hitherto unobserved line shapes. For rf with random phase, the resonance line is k-fold split, where k is the summation index of the Legendre polynomial expansion. If pulsed rf with a constant phase is used, form and symmetry of the resonances depend strongly upon the phase and the geometry of the experiment. The existence of a "hard core" value at resonance frequency is demonstrated. Various geometries are examined with respect to their applicability in angular correlation or nuclear reaction experiments. The possibility of obtaining the relative sign of gH with respect to a reference case at certain geometries and by using linearly polarized rf with a fixed phase is discussed. Gamma-ray detection of NMR is not only restricted to angular correlations and distributions but can also be performed by employing the Moessbauer effect. The principle is discussed and preliminary results obtained with ^{57}Fe are presented. Although the NMR interpretation is likely, the data do not, at present, unambiguously rule out the possibility of a frequency modulation effect. (auth)

50225 (UR–3388–10) ENDOR OF THE O_2^- ION IN POTASSIUM HALIDES. Doyle, A. M.; Castner, T. G. (Rochester Univ., N. Y.). June 1968. Contract AT(30-1)-3388. 6p. (CONF-680902–4). Dep. CFSTI.

From International Symposium on Color Centers in Alkali Halides, Rome Italy.

The ENDOR transitions of the neighboring nuclei in KCl, KBr, and KI were measured in an effort to ascertain the local distortion employing the electric field gradients obtained from the quadrupole tensors of the neighboring nuclei. ENDOR transitions of K and halogen nuclei neighboring the O_2^- ion were observed at 9.5 GHz at temperatures below 2.3°K. Rotation spectra were obtained and interpreted for the 4 nearest neighbor K's and also partly for the two K nuclei directly above and below the O_2^- ion. Many other K and halogen transitions were observed but not yet identified. (M.H.R.)

50226 LOW-TEMPERATURE RECOVERY OF 0.40-MeV ELECTRON-IRRADIATED ALUMINUM. Simpson, H. M.; O'Neal, T. N.; Pruitt, A. B.; Faust, W. E.; Chaplin, R. L. (Clemson Univ., S. C.). Phys. Lett., 27A: 559-60(Sept. 9, 1968).

Results are given for a high-resolution experiment on the low-temperature recovery of 0.40-MeV electron-irradiated aluminum. The data do not indicate structure for the I_D and I_E recovery regions. (auth)

50227 DETERMINATION OF DEFECTS IN POLYCRYSTALLINE NaCl FROM THE FORMATION OF ELECTRON CENTERS DURING ^{60}Co IRRADIATION. Rabe, J. G.; Joppien, G. (Hahn-Meitner-Institut fuer Kernforschung, Berlin). Z. Naturforsch., 23a: 1170-8(Aug. 1968). (In German).

The concentration of electron centers in polycrystalline NaCl formed during irradiation has been determined using a chemical method previously described. The influence on the formation of electron centers of thermal treatment, Ca^{++} doping, and grinding of the salt has been studied. The growth of electron centers with irradiation time was found to obey the equation given by Mitchell, Wiegand and Smoluchowski. In this equation occur the two types of anion vacancies present prior to irradiation, the rate of formation of new vacancies, and the rates of center formation from initial and new vacancies. Consistent with the Crawford–Nelson mechanism, the concentration of electron centers increases proportionally with the square root of the Ca^{++} concentration. At a Ca^{++}/Na^+ ratio of 2.5×10^{-4}, about 11 Ca^{++} are needed to form an additional electron center. The formation of defects by grinding the salt depends on its thermal pretreatment as well as on its Ca^{++} concentration. Most of the defects formed during grinding anneal when the salt is stored in moist air. When azoethane is adsorbed on preirradiated NaCl, the concentration of electron centers decreases. A quantitative evaluation of this effect leads to the conclusion that the concentration of defects formed by grinding the salt is orders of magnitude higher near the surface than in the bulk. (auth)

50228 MEASUREMENT OF ELECTRON ENERGY LOSSES IN STRONTIUM. Hartley, B. M. (Univ. of Western Australia, Perth). Phys. Lett., 27A: 499-500(Sept. 9, 1968).

Surface and volume plasmon energies of 3.6 ± 0.05 eV and 7.8 ± 0.1 eV are measured for strontium. Energy losses due to N_I and $N_{II\ III}$ ionization are identified, and a peak due to a polarization wave in the $N_{II\ III}$ band is identified in the characteristic electron energy loss spectrum. (auth)

50229 MECHANISM OF FORMATION AND CONVERSION OF COLOR CENTERS IN CsBr AND CsCl CRYSTALS. Lihl, F.; Vana, N. (Technishce Hochschule, Vienna. Atominstitut der Oesterreichischen Hochschulen, Vienna). Z. Angew. Phys., 25: 228-35(Sept. 6, 1968). (In German).

CsBr and CsCl crystals were irradiated with 380-keV electrons at 80°K. The mechanism of formation and conversion of the F, M, R, and α' centers is investigated with a combination of thermal and optical bleaching. An absorption band at 280 nm in CsBr and at 265 nm in CsCl, which is called the α' band, is associated with a complex center consisting of halogen ion vacancies. The mechanism of formation and conversion of the centers studied can only be explained by the assumption of complex centers and intermediate centers. (auth)

50230 MAGNETIC PROPERTIES AND MAGNETIC STRUCTURE OF THE COMPOUND ErAl. Becle, C.; Lemaire, R. (Laboratoire d'Electrostatique et de Physique du Metal, Grenoble, France. Laboratoire de Diffraction Neutronique, Grenoble, France). Phys. Lett., 27A: 541-2(Sept. 9, 1968). (In French).

ErAl shows metamagnetic properties below 10°K. The magnetic structure is noncolinear, the erbium moments are all parallel to the (001) plane, and they are almost perpendicular to the chains of atoms which lie along [010]. (auth)

50231 LIMITATIONS ON RELAXATION RATES OF ^{57}Fe IN CoO. Trousdale, W. (Wesleyan Univ., Middletown, Conn.); Craig, P. P. Phys. Lett., 27A: 552-3(Sept. 9, 1968).

By direct relaxation measurements and inference it is concluded that the occurrence of Fe^{+3} as well as Fe^{+2} Moessbauer spectra in some sources of ^{57}Co in CoO results from the effect of localized lattice heating following the decay of ^{57}Co upon atoms in the vicinity of lattice defects. (auth)

50232 POSSIBLE MECHANISM OF FORMATION OF COMPLEX RADIATION DEFECTS IN SILICON INTRODUCED BY ELECTRON IRRADIATION. Gorodetskii, S. M.; Kreinin, L. B. (Semiconductor Inst., Moscow). Dokl. Akad. Nauk SSSR, 181: No. 1, 46-8(July-Aug. 1968). (In Russian).

The primary defects (vacancies and internodal atoms) formed on irradiating single crystals of silicon with electrons are unstable, and secondary centers are formed by association of the primary defects with extraneous atoms or with each other. An attempt is made to determine the efficiency of introducing the secondary defects as a function of electron energy. The differential cross section is given for reaction of a relativistic electron with an atom of mass M, and the concentration of isolated

primary defects is estimated. The primary vacancies and internodal defects are then combined in various ways to give bound pairs which constitute the complex defects in the lattice. The concentration of various kinds of defects increases with increasing electron energy. The probability for the formation of associations of a bound pair with an impurity atom is proportional to the product of the concentration of complex defects and the impurity atom concentration. (TTT)

50233 POLARON FERROMAGNETISM OF EuB_6. Matthias, B. T. (Univ. of California, San Diego, La Jolla. Bell Telephone Labs. Inc., Murray Hill, N. J.). Phys. Lett., 27A: 511(Sept. 9, 1968).

An explanation is offered for the ferromagnetic behavior of EuB_6. (auth)

50234 N.M.R. IN TRANSITION AND RARE-EARTH METALS AND THEIR ALLOYS. Vijayaraghavan, R. (Tata Inst. of Fundamental Research, Bombay). Bull. Nat. Inst. Sci. India, No. 30, 16-19(1965).

Experimental work on metallic shifts specifically in transition and rare earth metals and their alloys are reviewed. The nmr shifts in platinum alloys are given and a theory is outlined to explain the shifts. In the second section nmr in ferromagnets is discussed and the origin briefly mentioned. Finally the shifts in rare earth systems are reported with relevant theory. (auth)

50235 NEUTRON DIFFRACTION WORK AT THE AVOGADRO RS1 REACTOR OF SORIN CENTER. Carraro, Giuseppe (Vetrocoke S.p.A.. Venezia, Italy); Domenici, Marcello; Zucca, Tarcisio. pp 787-800 of Fisica del Reattore. Rome, Consiglio Nazionale delle Ricerche, 1966. (In Italian).

From Conference on Physics of Reactors, Milan. See CONF-469.

Work performed or in progress at the Center is reported, starting from the installation and calibration of the neutron-diffraction equipment. Attention is given to structural studies of amorphous and semicrystalline solids. (M.O.W.)

50236 ANOMALOUS SKIN EFFECT FOR SPECULAR ELECTRON SCATTERING AND OPTICAL EXPERIMENTS AT NON-NORMAL ANGLES OF INCIDENCE. Kliewer, K. L.; Fuchs, Ronald (Ames Lab., Iowa). Phys. Rev., 172: 607-24(Aug. 15, 1968). (IS-1774).

The anomalous skin effect for specular electron scattering at the metal surface is studied, permitting the impinging plane wave to have an arbitrary angle of incidence. It is shown that the expressions for the surface impedance for a non-normal angle of incidence obtained by Reuter and Sondheimer as a generalization from their work at normal incidence are correct for S polarization but incorrect for P polarization. The correct surface impedance for P polarization leads to an additional absorption peak in the frequency range $10^{-2}\omega_p \lesssim \omega \lesssim \omega_p$, where ω_p is the free-electron plasma frequency. This additional absorption, particularly pronounced for long electron lifetimes, is investigated in detail. One important conclusion drawn from this work is that, in general, optical experiments performed at non-normal angles of incidence cannot be analyzed in terms of a single complex frequency-dependent dielectric function. In the frequency range of the additional P absorption, two such dielectric functions are needed, one function for describing P polarization and a different function for describing S polarization. (auth)

50237 UNSTABLE INTERMEDIATES. PART LIV. AN ELECTRON SPIN RESONANCE STUDY OF γ-IRRADIATED STRONTIUM CHLORIDE. Catton, R. C.; Symons, M. C. R. (Univ. of Leicester, Eng.). J. Chem. Soc., A, No. 9, 2155-8(1968).

γ-Irradiation of $SrCl_2$ at 77°K results in the formation of an electron-deficient defect which is closely related to the Cl_2^--center in alkali chlorides. The ESR spectrum is consistent with the model of the defect as a V_k-center weakly associated with two more chlorine nuclei. (auth) (UK)

50238 STATISTICAL MODEL OF PARTIALLY ORDERED DEFECTS IN UO_{2+X}. Atlas, Leon M. (Argonne National Lab., Ill.). J. Phys. Chem. Solids, 29: 1349-58(Aug. 1968).

A statistical model is developed for UO_{2+X} that accounts in an idealized way for defect ordering and its variation with temperature. The predominant defects are assumed to be interstitial oxygen ions in stable association with oxygen vacancies and U^{+5} ions, and also unassociated U^{+5} ions. Two kinds of order are considered: (a) the internal structure of a defect cluster, and (b) the nonrandom distances between clusters and also between free U^{+5} ions. The cluster structure is analyzed on the basis of a model proposed by Willis, and the variation of spacing by a procedure that changes a control parameter by integral amounts to generate a series of levels of defect interaction energy. An estimate is also presented for the vibrational contribution of excess oxygen in UO_{2+X}. For this calculation, it is assumed that the interstitial and normal anions have very similar oscillator behavior and that the frequencies of all of the anions are raised by the contraction of the structure as X increases. Thermodynamic data derived from the statistical model agree fairly well with published experimental results. Curves of the computed data vs X show slope irregularities in regions that coincide in a general way with known two-phase fields. (auth) (UK)

50239 SOLID STATE PHYSICS RESEARCH USING A 1 MW REACTOR. Paoletti, Antonio (CNEN, Rome). pp 823-8 of Fisica del Reattore. Rome, Consiglio Nazionale delle Ricerche, 1966. (In Italian).

From Conference on Physics of Reactors, Milan. See CONF-469.

Use of a polarized-neutron spectrometer for Fe_3Si and $MnNi_3$ systems studies is described. Magnetic moments of a unitary cell of Fe_3Si are listed; order parameter measurements for $MnNi_3$ systems are described. Measurements of magnetic coherent scattering of thermal neutrons by face centered cubic cobalt at high temperatures are summarized. 14 references. (M.L.S.)

50240 HYPERFINE FIELD OF ^{237}Np IN NpO_2. Dunlap, B. D.; Kalvius, G. M.; Lam, D. J.; Brodsky, M. B. (Argonne National Lab., Ill.). J. Phys. Chem. Solids, 29: 1365-7(Aug. 1968).

Nuclear hyperfine spectra, obtained by means of the Moessbauer effect of the 59.6-keV transition in ^{237}Np, were investigated in NpO_2 between 4.2 and 30°K. At low temperatures, a broadening of the resonance line was observed which is interpreted to be a small, unresolved magnetic splitting. From the size of the magnetic hyperfine field the magnetic moment on the Np atom is estimated to be of the order of 0.01 μ_B. These results confirm the presence of antiferromagnetic ordering in accordance with previous magnetic susceptibility and heat capacity data, and in addition show that the magnetic moment in the ordered state is unusually low, as was indicated by previous neutron diffraction measurements. (auth) (UK)

50241 STRUCTURE OF THE PARAMAGNETIC LITHIUM CENTER IN ZINC OXIDE AND BERYLLIUM OXIDE. Schirmer, O. F. (Institut fuer Elektrowerkstoffe, Freiburg i. B.). J. Phys. Chem. Solids., 29: 1407-29(Aug. 1968).

If ZnO and BeO crystals containing Li are irradiated with uv or x rays a paramagnetic defect center is created consisting of a hole captured at an O^{2-} ion next to a substitutional Li^+ impurity. Because of the polarity of the crystals the hole assumes its lowest energy if the $O^- - Li^+$ direction coincides with the polar c-axis. The energy separation to the three nonaxial hole positions was determined by studying the variation of the population of both types of sites with the temperature. The transitions of the hole between its four eligible positions gives rise to motional effects observable in the ESR spectra. From an analysis of the anisotropic Li hfs interaction it is concluded that the $Li^+ - O^-$ distances are 40% longer than the normal bond lengths in both crystals. Negative contact hfs interaction with the Li nucleus is observed in both host lattices. This sign is predicted by a calculation which takes into account the exchange interaction of the Li^+ 1s electrons with the unpaired electron. Exchange polarization of "closed states" of the O^- ion is responsible for "negative spin density" observed at the Be nuclei surrounding the O^- ion of the center in BeO. The $g_\perp$ value of the ZnO: Li center depends on the mass of the Li isotope present. A theory treating the vibronic interaction within the center is able to explain the observed sign and order of magnitude of this isotope shift. (auth) (UK)

50242 "BLOCKING" OF D^+ IONS IN SINGLE CRYSTAL GOLD FILMS. Andreen, C. J. (Chalmers Univ. of Tech., Gothenburg, Sweden). Ark. Fys., 35: 595-604(1968). (COO-1053-11).

Blocking effects are believed to be observed along the directions (011), (001), (112), and (123) in gold. Planar blocking along (111)- and (110)-type planes is also suggested. The experimental result involving a complicated combination between planar and directional effects due to both channeling and blocking, cannot be subject to analytical treatment at the present time. (Sweden)

50243 HEAT CAPACITY OF TETRAURANIUM ENNEAOXIDE (U_4O_9) FROM 1.6° TO 24°K. THE MAGNETIC CONTRIBUTION TO THE ENTROPY. Flotow, Howard E.; Osborne, Darrell W.; Westrum, Edgar F. Jr. (Argonne National Lab., Ill.). J. Chem. Phys., 49: 2438-42(Sept. 1, 1968).

The heat capacity of $UO_{2.25}$ has been determined calorimetrically from 1.6° to 24°K and found to be significantly higher than that of UO_2 or ThO_2. There is no λ-type thermal anomaly in the region of the maximum in the magnetic susceptibility near 6.4°K. The heat capacity is proportional to T^2 below 2.7°K. An approximate resolution of the entropy into lattice and magnetic components indicates that the magnetic entropy is about 70% that of UO_2 near 200°K. (auth)

50244 RARE-EARTH INFRARED LIFETIMES AND EXCITON MIGRATION RATES IN TRICHLORIDE CRYSTALS. Gandrud, W. B.; Moos, H. W. (Johns Hopkins Univ., Baltimore). J. Chem. Phys., 49: 2170-82(Sept. 1, 1968).

Lifetimes of trivalent rare-earth ion levels below 14,000 cm^{-1} have been measured in the $LaCl_3$, $GdCl_3$, and YCl_3 hosts, using the infrared quantum counter and ir fluorescence techniques. Because of their low radiative and multiphonon relaxation rates, these levels are well suited to concentration-quenching studies. Temperature dependences provide evidence that the ion-pair decays of $^3H_6$ and $^3F_3$ in Pr^{3+} and $^4I_{13/2}$ and $^4I_{11/2}$ in Nd^{3+} occur resonantly (i.e., without phonon assistance) between excited Stark components. This enables the measured decay rates for these four levels to be used in estimating the rate for a single resonant transfer of all of the ion's energy to a neighboring ion. This latter process is the basic step of the excitation–migration process. From the lifetimes of a number of levels quenched by migration to "sinks," an estimate of 4×10^5 is then obtained for the number of transfers that occur before a sink is reached. Levels quenched by migration to sinks are found to decay exponentially, with a lifetime that increases with increasing crystal purity. (auth)

50245 FERMI SURFACE IN MOLYBDENUM. Galkin, A. A.; Zhevago, S. E.; Butenko, T. B.; Degtyar, E. P. (Inst. of Physics and Tech., Erevan). Ukr. Fiz. Zh., 13: 1106-8(July 1968). (In Russian).

The anisotropy of $\alpha(\vec{H})$ in a molybdenum crystal is investigated for the case $\vec{q} \perp \vec{H}$ and $\vec{q} \| \vec{H}$ [100], ultrasound frequency being 200 MHz. An experimental extremal size of the electron bands ΓX of the Fermi surface are in qualitative agreement with the Lomer model. (auth)

50246 ELECTRON ABSORPTION PROPERTIES OF THE SCANDIUM FILMS ON THE (110) FACE OF TUNGSTEN. Voronin, V. B.; Naumovets, A. G. (Inst. of Physics, Kiev). Ukr. Fiz. Zh., 13: 1382-93(Aug. 1968). (In Russian).

The adsorption of scandium on the (110) face of tungsten was investigated by the contact potential method. The shape of the work function curves, depending on the deposition time of Sc, is strikingly different at various temperatures of the substrate. The effect is believed to be due to the difference of the structure of the adsorbed films under these conditions. The data on the heat of adsorption of Sc on the (110) face of tungsten were also obtained from the adsorption isobars. The heat of adsorption decreases from 4.8 eV at low coverages to 3.7 eV (sublimation energy of scandium) at surface concentration of Sc atoms of 1.2×10^{15} cm^{-2}. (auth)

50247 DICARBIDES OF EUROPIUM AND OTHER RARE-EARTH METALS. Matyushenko, N. N.; Svinarenko, A. P. (Kharkov Inst. of Physics and Tech., Moscow). Ukr. Fiz. Zh., 13: 1083-5(July 1968). (In Russian).

The europium dicarbide is obtained in the Eu_2O_3–C system at 1800°K. It has the fcc cell with $a = 0.596_{1\pm1}$ nm. The volume of the europium dicarbide is compared with volumes of the well-known rare-earth metal dicarbides. The decrease of 0.006 nm^3 from additivity is established for EuC_2, BaC_2, and CaC_2. The volume variation is connected with an electron structure of rare-earth elements. (auth)

50248 COINCIDENCE-MOESSBAUER SPECTROSCOPY. Hamill, Dennis W.; Hoy, Gilbert R. (Boston Univ.). Contract AT(30-1)-3973. Phys. Rev. Lett., 21: 724-6(Sept. 9, 1968). (NYO-3973-1).

It is shown that in analyzing coincidence-Moessbauer data it is necessary to include the finite resolution time determined by the electronics. By so doing, one is able to fit spectra in which only "time filtering" effects are present. Results are also presented showing the enhanced resolution capability of this technique. (auth)

50249 STACKING FAULTS IN TUNGSTEN. Garber, R. I.; Dranova, Zh. I.; Mikhailovskii, I. M. Sov. Phys.-Solid State (Engl. Transl.), 10: 799-801(Oct. 1968).

Translated from Fiz. Tverd. Tela, 10: 1012-15(Apr. 1968).

The splitting of dislocations in tungsten has been studied by means of the field-emission microscope. The formation of stacking faults was observed in the {111} and {110} planes. Splitting of the edge dislocation ½ [111] in the {111} plane leads to the formation of a sessile dislocation. The stacking-fault energy in the {111} plane is about 137 and that in the {110} plane is 50 ergs/cm^2. The extent of splitting in dislocation walls which form small-angle subgrain boundaries does not exceed 8 to 10 Å. (auth)

50250 DISTRIBUTION AND RANGE OF BORON AND PHOSPHORUS IONS USED IN BOMBARDMENT OF SiO_2. Volod'ko, V. G.; Zorin, E. I.; Pavlov, P. V.; Tetel'baum, D. I. (Gorky State Univ.). Sov. Phys.-Solid State (Engl. Transl.), 10: 828-31 (Oct. 1968).

Translated from Fiz. Tverd. Tela, 10: 1048-52(Apr. 1968).

An experimental study was made of the distribution of boron and phosphorus ions implanted in SiO_2 by ion bombardment. The range of energies for boron was 30 to 100 keV, and for phosphorus it was 50 to 150 keV. The distribution was investigated by bombarding n- and p-type silicon covered with SiO_2 films of various thicknesses. After annealing, which transferred all the implanted impurity atoms to an electrically active state and healed radiation defects, an oxide film was removed in HF and the surface resistivity was used to determine the number of ions which had penetrated the oxide film. The distributions obtained had maxima at some distance from the surface. In both cases the "median" range was in good agreement with the Lindhard–Scharff theory. Inclusion of the "shell" correction in the expression for the electronic damping in the Lindhard–Scharff theory impaired the agreement with the experiment data. The mean square scatter of the values of the range (or the half-width of the distribution curve) exceeded considerably the values predicted by the Lindhard–Scharff theory. Evidently, this was mainly due to the role of considerable energy transfer in individual collisions during the slowing-down process, which was not allowed for in this theory. (auth)

50251 ELECTRON EMISSION DUE TO BOMBARDMENT OF NaCl AND KCl SINGLE CRYSTALS WITH SLOW INERT-GAS IONS INCIDENT AT VARIOUS ANGLES. Petrov, N. N.; Volkov, N. F.; Kondrashev, A. I. (Kalinin Polytechnical Inst., Leningrad). Sov. Phys.-Solid State (Engl. Transl.), 10: 832-6(Oct. 1968).

Translated from Fiz. Tverd. Tela, 10: 1053-7(Apr. 1968).

The results are described of an experimental investigation in which (001) faces of NaCl and KCl single crystals were bombarded with He and Ne ions of 70 to 700 eV energies. The dependence of the electron emission coefficient γ on the angle of incidence φ of ions was investigated by rotating targets about the [001] and [011] axes from −60 to +60°. At energies $E_0 \gtrsim 150$ eV, the dependence $\gamma(\varphi)$ was found to be nonmonotonic and the values of γ had minima for the motion of ions along the most "transparent" crystallographic directions. It was observed that a reduction of the ion energy to 70 to 100 eV smoothed out the $\gamma(\varphi)$ curve and the values of γ ceased to depend on the angle of incidence of ions. The results obtained for different ions and crystals were compared and discussed. (auth)

50252 TRIVALENT RARE EARTHS IN SINGLE CRYSTALS OF CERIUM DIOXIDE. SPIN–LATTICE RELAXATION OF TRIGONAL Dy^{3+} CENTERS AND CUBIC Yb^{3+} CENTERS. Shekun, L. Ya.; Antipin, A. A.; Zonn, Z. N.; Katyshev, A. N.; Kurkin, I. N. (Ulyanov–Lenin State Univ., Kazan). Sov. Phys.-Solid State (Engl. Transl.), 10: 843-7(Oct. 1968).

Translated from Fiz. Tverd. Tela, 10: 1065-70(Apr. 1968).

The spin-lattice relaxation time T_1 of trigonal Dy^{3+} centers and cubic Yb^{3+} centers in single crystals of CeO_2 grown from a solution in the melt is measured at frequencies 3, 9.4, and 36 kMHz. Spin-lattice relaxation times greater than 10^{-5} sec are measured by the pulse saturation technique, and values in the range 10^{-5} to 10^{-7} sec by the continuous saturation method; relaxation times shorter than 3×10^{-8} sec are estimated from the spin-phonon broadening of the EPR line. The temperature dependence of the spin-lattice relaxation time was found to be $1/T_1 = 4.5 \times 10^3 T + 3 \times 10^{10} e^{-49/T}$ for trigonal Dy^{3+} centers and $1/T_1 = 2 \times 10^2 T + 1.1 \times 10^{-2} T^{4.5} + 9 \times 10^{-3} T^3 f(\theta/T)$ for Yb^{3+} centers. The temperature dependence of the spin-lattice relaxation of the cubic Yb^{3+} centers was employed to determine the Debye temperature Θ for the CeO_2 lattice: Θ = (720 ± 50)°K. The frequency dependence of single-phonon processes is anomalous. The relaxation time T_1 increases almost linearly with increasing frequency. (auth)

50253 POTENTIAL AND KINETIC ELECTRON EMISSION FROM THE (110) AND (111) FACES OF A Mo SINGLE CRYSTAL. Arifov, U. A.; Rakhimov, R. R.; Dzhurakulov, Kh. (Electronics Inst., Tashkent). Sov. Phys.-Solid State (Engl. Transl.), 10: 925-8(Oct. 1968).

Translated from Fiz. Tverd. Tela, 10: 1166-72(Apr. 1968).

The experimental results are given of an investigation into the electron emission from the (110) and (111) faces of a Mo single crystal by means of beams of helium and argon ions and atoms in the energy range $E_0 = 0.2$ to 5.0 keV. The intensity of the neutral atoms was measured by a calorimetric method, using semiconducting microthermistors. The neutral-atom detector was calibrated against a stream of electrons. The crystals were cleaned in a vacuum of about 5×10^{-8} mm Hg by prolonged heating at temperatures up to about 2300°K. The surface condition of the crystals was checked by measuring the thermoelectronic work function φ. The values of φ measured in the final stage of heat treatment were: $\varphi_{110} = 4.90 \pm 0.05$ and $\varphi_{111} = 4.14 \pm 0.05$ eV. It is shown that on changing from the (110) face to the (111) face the coefficient of potential electron emission (γ_p) for Ar^+ and He^+ in-

creases by 1.5 and 1.1 times, respectively, while the electron energy spectra are enriched by faster electrons. The dependence of the coefficient of kinetic electron emission (γ_k) on E_0 has a steeper slope for the (110) face than for the (111) face and is related mainly to the transparency of the crystal in the given direction. The energy spectrum of the kinetic-emission electrons from the close-packed face is softer than that from the more open face. The change in the energy-distributed curve of electrons of both potential and kinetic emission on passing from one face to the other is not directly related to the change in φ. The difference in the potential and kinetic electron emission from the two faces is associated with the character of the energy spectrum of the emitted electrons, with the interaction of electrons excited in the metal with the conduction-band electrons, and with the crystal structure and work function of the target. A decrease is observed in the anisotropy of γ_k with reduction in the mass of the bombarding atom; this is due to the relative cross-sectional dimensions of the incident atom and to the open channels in the lattice and also to the ratio of the masses of the colliding particles. (auth)

50254 F CENTERS IN HEXAGONAL BORON NITRIDE ENRICHED WITH THE ^{10}B ISOTOPE. Khusidman, M. B.; Neshpor, V. S. (State Inst. for Applied Chemistry, Leningrad). Sov. Phys.-Solid State (Engl. Transl.), 10: 975-6(Oct. 1968).

Translated from Fiz. Tverd. Tela, 10: 1229-31(Apr. 1968).

The EPR spectrum of F centers in natural BN is described. A hyperfine interaction constant of 2.4 Oe is calculated for the ^{10}B isotope; the EPR spectrum should consist of a single line. BN enriched 95% with ^{10}B was synthesized, and its EPR spectrum was found to coincide with the calculated spectrum. Measurements of the F-center concentrations are also reported. (D.L.C.)

50255 CORRELATION BETWEEN CHANGES IN THE LATTICE CONSTANT AND ELECTRICAL CONDUCTIVITY OF LITHIUM FLUORIDE SINGLE CRYSTALS DUE TO X-RAY IRRADIATION. Golubeva, L. A.; Shishelov, A. A. (Kalinin Polytechnical Inst., Leningrad). Sov. Phys.-Solid State (Engl. Transl.), 10: 1002-4(Oct. 1968).

Translated from Fiz. Tverd. Tela, 10: 1256-8(Apr. 1968).

Equations are given for the lattice constant of LiF single crystals as a function of x-ray dose. A comparison is carried out of the changes in the lattice constant and the electrical conductivity and the activation energy of carriers. Samples were cleaned from a single crystal grown in air, and irradiated with x-ray doses up to 400×10^8 R. The temperature dependence of the electric conductivity of irradiated crystals showed two regions of opposite tendencies, with a crossover point at 130°C. The activation energy was found to follow a law similar to that for the lattice constant, but its changes are probably due to defects other than F centers. The effects of magnesia dopant and growth in vacuum on the electric conductivity and activation energy are described. (D.L.C.)

50256 RECENT DEVELOPMENTS IN CRYOGENIC TECHNIQUES AT THE GRENOBLE CENTRE FOR NUCLEAR STUDIES. Bochirol, Louis (CEN, Grenoble, France). Ind. At., 12: No. 7-8, 29-38(1968). (In French).

Cryogenic apparatus developed at the CEN-G for irradiations at 20, 30, and 80°K is described, and a few of the recent results obtained on creation of defects in solids by irradiation are discussed. Examples of studies preparatory to implantation of a source of cold neutrons in the high-flux Franco–German reactor are briefly presented. (tr-auth)

50257 POSITRON ANNIHILATION AS A PROBE FOR MANY BODY EFFECTS IN METALS. Mihalisin, Ted Warren. Rochester, N. Y., Univ. of Rochester, 1968. 205p.

Thesis.

The use of conventional Fermi surface measuring techniques such as the de Haas–Van Alphen effect, magnetoresistance, and cyclotron resonance has proven infeasible in the studies of certain many-body effects in metals. Purity limitations and the intrinsic inability to distinguish majority and minority spin orbits have hampered de Haas–Van Alphen and other techniques in the study of the ferromagnetic state of transition metals. The Meissner effect and the destructive effect of high magnetic fields have precluded the use of many techniques for the investigation of the electron momentum distribution characteristic of the superconducting state. The primary objective of this work was to explore the capabilities of the positron annihilation technique in the studies of the superconducting and ferromagnetic states. Earlier attempts to observe the momentum smearing in soft superconductors utilized angular resolutions which were a factor of 10 to 100 times too large to observe the predicted effect. The intermetallic compound V_3Si was chosen for the superconductivity experiment because it has the smallest reported coherence length and consequently the largest momentum smearing. Due to the radical 3d Fermi surface predicted for this material by Weger, room-temperature measurements were performed on (111) and (100) single crystals. The isotropic results largely discredited this prediction and were consistent with a later calculation by Mattheiss. In positron annihilation studies on superconducting V_3Si no change (to ± 0.1%) in the coincidence rate was observed for three angles near the Fermi angle. Since the predicted effect was in excess of 2%, the negative result seemed inexplicable until subsequent experiments by Kim, Stewart, and Carbotte indicated that the thermalization of positrons may be incomplete below 100°K which could have camouflaged the effect. Earlier work of Mijnarends and Hambro, and Berko and Zuckerman demonstrated that spin-polarized positron annihilation studies can give information concerning the momentum distribution of spin moments in a ferromagnetic metal. In this work angular correlation studies were made on (111), (100) and (110) single crystals of nickel. The observed structure and anisotropy confirm the existence of distinct majority and minority spin Fermi surfaces which are crucial to the band approach to ferromagnetism. Anisotropy in the low-momentum spin moment discredits the existence of a negatively spin-polarized conduction band in this material. The interpretation of spin-polarized positron studies is shown to be complicated by the contribution of two inequivalent planes through the Fermi sea. A new technique which measures the intersection of lines through the Fermi sea is proposed as a method for resolving Fermi surface detail. (Disser. Abstr.)

50258 COLOR CENTERS IN MgF_2. Sibley, W. A.; Facey, O. E. (Oak Ridge National Lab., Tenn.). Phys. Rev., 174: 1076-82(Oct. 15, 1968).

The effects of radiation temperature and intensity on the colorability of MgF_2 single crystals obtained from various commercial sources were investigated. The results show that the radiation-damage process in MgF_2 is photochemical in nature and strikingly similar to that in the alkali halides. In the past it has been proposed that long-range focusing events are, in part, responsible for the photochemical coloration of the alkali halides. However, in MgF_2 there are no obvious long-range focusing directions, and the data suggest that such a process is not necessary for the production of photochemical damage. The radiation equilibrium observed to prevail between F and M centers in KCl is also evident in MgF_2, and this effect was used to propose that absorption bands at 370 and 400 nm are due to M centers. (auth)

50259 DIRECT OBSERVATION OF SOLID-STATE DIFFUSION USING THE MOESSBAUER EFFECT. Knauer, Robert C.; Mullen, James G. (Purdue Univ., Lafayette, Ind.). Phys. Rev., 174: 711-13(Oct. 15, 1968).

Iron diffusion in copper has been measured using the Moessbauer effect. The temperature dependence of the Moessbauer line broadening is proportional to the temperature dependence of the diffusivity as determined by the tracer-sectioning technique. The magnitude of the broadening is about $\hbar/\tau$ (where τ is the mean time an atom spends at a given site), instead of $2\hbar/\tau$ as predicted by the jump model of diffusion. No evidence for sidebands is observed in the broadened Moessbauer spectra, which have approximately Lorentzian line shape. The temperature dependence of the recoil-free fraction appears to be anomalously large in the region where diffusion broadening of the Moessbauer line was observed. (auth)

50260 RECOVERY OF RESISTIVITY OF PURE AND ALLOYED ALUMINUM IN STAGES II AND III AFTER 2-MeV ELECTRON IRRADIATION. Peters, P. B.; Shearin, P. E. (Univ. of North Carolina, Chapel Hill). Phys. Rev., 174: 691-700(Oct. 15, 1968).

Samples of pure aluminum and aluminum alloyed with 0.3 at. % Zn, Cu, and Ge were irradiated by 2-MeV electrons to several widely differing doses and at a variety of temperatures. Isochronal annealing studies were performed with 30-min anneals spaced 5° apart from 60°K to the conclusion of stage III. In one experiment a pure aluminum and a zinc-alloy sample were exposed to air when at a temperature of 300°C prior to irradiation. The presence of the additional air impurities was found to impede the motion of the defect migrating in stage III. Impurity effects dominate the recovery through the stage-II region and extend into stage III, although the possibility of an intrinsic process near 73°K exists. From the results of this work, the stage-III recovery in pure aluminum can be explained in terms of a model where single vacancies migrate to clusters of interstitials that were formed during the preceding stages of annealing. (auth)

Theoretical Physics

Refer also to abstract 48850.

50261 (UCRL-50472) DECONVOLUTION OF SPECTRAL-DEPENDENT MEASUREMENTS. Richter, H. P. (California

Univ., Livermore. Lawrence Radiation Lab.). June 12, 1968. Contract W-7405-eng-48. 8p. Dep. CFSTI.

A method for determining signal functions by deconvoluting a series of physical measurements when apparatus response and output functions are known is presented. The presentation includes the case in which the output function consists of a single value as well as the case in which the response function has several discontinuities. Both of these cases normally are not found in the literature. Two approaches to the deconvolution method are described and the advantages of each are stated. One of these approaches uses analytical integration to obtain a system of linear equations. The other results in a system of nonlinear equations applicable to more difficult numerical situations. Although the described deconvolution method has been applied specifically to a series of spectral measurements, the discussion indicates the usefulness of the method in solving other physical and mathematical problems. (auth)

50262 GREEN FUNCTION AND QUASI-ENERGY SPECTRUM OF THE ELECTRON IN THE ELECTROMAGNETIC WAVE FIELD AND IN A UNIFORM MAGNETIC FIELD. Oleinik, V. P. (Inst. of Semiconductors, Kiev). Ukr. Fiz. Zh., 13: 1205-14(July 1968). (In Russian).

The Green function of the electron in the electromagnetic wave field and in a uniform magnetic field is obtained when the direction of the wave propagation coincides with the direction of the magnetic field. It is shown that at a given quantum numbers n and σ (n the number of the Landau-level, σ spin of the electron) the quasi-energy spectrum of the system contains two characteristic points: the point of discontinuity and the point of intersection of the electron and positron branches. These peculiarities result in the fact that the photon forming of the electron–positron pair in the electromagnetic wave field and in a uniform magnetic field is not forbidden even in a case when the energy of the pair forming photon is much less than mc^2. (auth)

50263 THEORY OF STRONGLY INTERACTING QUANTUM LIQUIDS. I. FORMULATION. McMillan, W. L. (Bell Telephone Labs., Murray Hill, N. J. Cambridge Univ., Eng.). Phys. Rev., 175: 266-71(Nov. 5, 1968).

The ground state ψ_0 and elementary excitation ψ_q of the strongly interacting Bose gas were used to construct a theory of strongly interacting mixed and Fermi gases. The overcomplete basis set $\phi^k\psi_q$ is considered, where ϕ^k is a determinant of plane waves, and off-diagonal part of the hamiltonian is interpreted as a three-point vertex, coupling the Fermi quasi particles to the collective modes. This vertex dresses each fermion with its backflow and induces a two-fermion scattering via the interaction of the backflows. There is no residual (screened) two-body interaction in the problem. Finally the expansion parameter is discussed for strong interactions. (auth)

50264 COUPLING OF DENSITY AND SPIN FLUCTUATIONS TO QUASI PARTICLES IN A FERMI LIQUID. Amit, D. J.; Kane, J. W.; Wagner, H. (Cornell Univ., Ithaca, N. Y.). Phys. Rev., 175: 313-26(Nov. 5, 1968).

The general interaction between quasi particles and particle-hole excitations in a neutral Fermi system at T = 0 is investigated. Density and spin-density fluctuations and collective modes are treated on an equal basis. Use is made of Ward identities to relate the vertex function Γ to the quasiparticle self-energy Σ, and logarithmic corrections to the self-energy are obtained. The coefficients of the logarithmic terms are calculated analytically in terms of known Landau parameters. (auth)

50265 LOGARITHMIC TERMS IN THE SPECIFIC HEAT OF A NORMAL FERMI LIQUID. Amit, D. J.; Kane, J. W.; Wagner, H. (Cornell Univ., Ithaca, N. Y.). Phys. Rev., 175: 326-31 (Nov. 5, 1968).

Using the properties of the mass operator and vertex function derived previously, corrections of the form T^3 ln T were calculated to the term in the specific heat C_V that is linear in the temperature. The connection of this calculation with the microscopic theory is pointed out and the limitations are discussed. (auth)

50266 UNITY OPERATOR FOR COHERENT STATES. Campagnoli, G.; Zambotti, G. (Univ., Pavia, Italy. Istituto Nazionale di Fisica Nucleare, Pavia, Italy). Nuovo Cim., 57A: 468-74 (Oct. 1, 1968).

In the Hilbert space of the states of one harmonic oscillator, two different expansions of the unity operator are well known; one involving the eigenstates of the number operator, and the other involving the whole set of the coherent states. A third expansion of the unity operator is investigated, involving a subset of the set of the coherent states; furthermore, such an expansion is applied to the construction of a particular kind of Bargmann space, and to the problem of expanding arbitrary operators. (auth)

50267 SPECIAL RELATIVITY AND QUANTUM MECHANICS. Halpern, Francis R. Englewood Cliffs, N. J., Prentice-Hall, Inc., 1968. 143p. $4.95.

Chapters are included on the following: (1) algebraic properties of the Lorentz group and its relation to the special linear group, (2) implications of the special theory of relativity for quantum mechanics, (3) choice of phases in the unitary operators that represent the Poincaré group, (4) unitary representations of the Poincaré group, (5) the improper operations: parity and time reversal, (6) the combination of relativistic systems, and (7) the interaction of relativistic systems. (M.O.W.)

50268 EXCLUSION PRINCIPLE AND EQUIVALENT POTENTIALS FOR SCATTERING OF COMPLEX NEUTRAL PARTICLES. Swan, Peter (Univ. Laval, Quebec). Ann. Phys. (N. Y.), 48: 455-92(July 1968).

In many cases of atomic or nuclear scattering involving two complex particles, the Pauli exclusion principle forbids formation of compound cluster states with certain intercluster quantum numbers. This occurs whenever the compound state would involve more than a full shell of electrons, neutrons, or protons. Instead, the particles are repelled into the first available excited principal quantum number state n'_{lj} of the center-of-mass motion of the two composite particle clusters. For M_{lj} excluded compound states (differing only in n-values), the phase/binding energy-equivalent two-body potential should have a repulsive core $V(r \to 0) \to 2M_{lj}(2l + 2M_{lj} + 1)(\hbar^2/\mu r^2)$. The lj-state two-body wave function $u_{lj}(r)$ thus behaves like an $(l + 2M_{lj})$-state function for $r \to 0$, $u_{lj}(r \to 0) \approx r^{l+2M_{lj}+1}$. A distorted inverse square barrier wave approximation (DISBWA) enables one to deduce these repulsive core potentials for any ljM_{lj} combination. For l = 0, the Pauli barrier may be conveniently approximated by an Eckart potential, and the DISBWA wavefunction has an analytic form. An application to elastic $n-\alpha$ scattering phases results in an entirely repulsive potential for l = 0, the small attractive optical-model potential being completely swamped by the Pauli barrier. A physical interpretation pictures the α-particle nucleons with large l = 0 and small $l \geq 1$ components in the $n-\alpha$ system. The l = 0, S = 1, n–n component leads to a $6\hbar^2/\mu r^2$ repulsion, which is "damped" by the incident neutron interaction with the other three α–nucleons, giving a finite barrier range $1/\lambda_B$. The $l \geq 1$ components result in the small optical model interaction with the l = 0 incident neutron. (auth)

50269 SIMPLE CONDENSATION OF INTERACTING BOSONS. Casher, A.; Revzen, M. (Technion–Israel Inst. of Tech., Haifa). Ann. Phys. (N. Y.), 48: 441-54(July 1968).

Bose condensation is characterized by a condition on the zero-frequency fourier component of the self-energy at the critical value of the chemical potential. This condition is used to show that under the action of an external linear perturbation the k = 0 mode goes over into a coherent state in the sense discussed by Glauber. Both the interparticle interaction and the external perturbation are treated exactly. (auth)

50270 RESONANCE PHENOMENA AND THE NON-APPLICABILITY OF THE "THIRD" INTEGRAL. Contopoulos, G. (Goddard Inst. for Space Studies, New York). Bull. Astron. [3rd Ser.], 2: 223-41(1967).

In recent years it has become evident that integrals of motion beyond the energy and angular momentum ("third" integrals) exist in most problems near integrable ones, such as motions of stars in an axially symmetric galaxy, and the motions of charged particles in the Van Allen belts. An explanation is offered for the dissolution of the invariant curves and the corresponding non-applicability of the "third" integral. For each ratio of unperturbed frequencies A^k/B^k there correspond resonance phenomena which are represented by "islands" on the surface of section, corresponding to many rational numbers n/m near A^k/B^k. As the perturbation increases, the area covered by the islands increases as $\epsilon^{k(m+n-4)}$, and the number of important islands (those with m + n small) increases as ϵ^2. If ϵ exceeds a certain critical value ϵ_d there is overlapping of the islands and a corresponding dissolution of the invariant curves. A rough estimate of the critical perturbation ϵ_d can be given by the theory of the third integral. It has no connection with the escape perturbation. The experimental results of the special case $A^k/B^k = 4/3$ are considered. (BBB)

50271 SURFACE PHENOMENA IN FERMI LIQUIDS. Feibelman, Peter J. (Univ. of California, San Diego, La Jolla). Ann. Phys. (N. Y.), 48: 369-406(July 1968).

A general theory of surface phenomena is presented for a zero-temperature Fermi liquid. The similarities between classical and quantum surface motion are studied, the comparison leading to an expression for the surface energy of the liquid. It is shown, within the time-dependent self-consistent field approximation, that the dynamical modes of the system include Landau's zero-sound waves

as well as surface vibrations. Exploiting the close relation between "spurious modes" and surface waves, an approximate dispersion relation is derived for the latter. It is shown that the existence of a gap in the fluid's particle–hole spectrum is essential if surface modes are to propagate. Thus in a "normal" Fermi-fluid odd-parity vibrations propagate at sufficiently long wavelength while even-parity ones are damped. The effect of surface modes on the nuclear optical potential is studied. The propagation of such modes implies a peak in absorption at the surface of the nucleus. The observation of surface waves in ^{3}He is also discussed. (auth)

50272 QUANTUM MECHANICS. Newing, R. A.; Cunningham, J. University Mathematical Texts. New York, John Wiley and Sons, Inc., 1967. 233p. $4.50.

Chapters are presented on the following: (1) vector spaces and linear operations, (2) general principles of quantum mechanics, (3) the Schroedinger coordinate representation, (4) scattering theory, (5) angular momentum, (6) electron spin, (7) approximate methods, and (8) the Dirac electron. (M.O.W.)

50273 ASYMPTOTIC BEHAVIOR OF STIELTJES TRANSFORMS. II. Woolcock, W. S. (University Coll., London). J. Math. Phys. (N. Y.), 9: 1350-6(Sept. 1968).

The results of a previous paper concerning the asymptotic behavior of Stieltjes transforms for large $|z|$ are extended to prove theorems which hold uniformly for all directions in the complex plane. Special additional assumptions, which hold for all sufficiently large values of the argument of the function whose transform is taken, are required to obtain these extended results. (auth)

PHYSICS (HIGH ENERGY)

Particle Interactions and Properties (Experimental)

Electromagnetic

50274 (DESY-68/42) THE TRANSVERSE AND LONGITUDINAL CROSS SECTIONS FOR ELECTROPRODUCTION OF PIONS NEAR THE Δ(1236)-ISOBAR. Bartel, W.; Dudelzak, B.; Krehbiel, H.; McElroy, J.; Meyer-Berkhout, U.; Schmidt, W.; Walther, V.; Weber, G. (Deutsches Elektronen-Synchrotron, Hamburg (West Germany). Hamburg Univ. (West Germany). II. Institut fuer Experimentalphysik). Aug. 1968. 14p. Dep.

The reaction $e + p \rightarrow e' + N^*$ was studied for four momentum transfers up to 2.34 $(GeV/c)^2$ in the region of the 1236 MeV isobar. An analysis of the data in terms of the cross sections σ_T and σ_L for the absorption of transverse and longitudinal photons is given for invariant masses of the final pion nucleon system W = 1.220 GeV and W = 1.350 GeV. (auth)

50275 (JINR-P1-4023) FORMATION OF (e^+e^-) PAIRS BY ELECTRONS WITH 1.25 TO 4 GeV ENERGIES. Bem, Ya.; Grishin, V. G.; Muminov, M. M.; Strel'tsov, V. N. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of High Energy). 1968. 19p. (In Russian). Dep.

A propane bubble chamber was used for measuring the cross section of (e^+e^-) pair production by electrons at 1.25 to 4 GeV. Obtained experimental and theoretical data are in good agreement. A special method was developed for measuring small distances in the bubble chamber. (tr-auth)

50276 (ORNL-TM-2275) PROTON-PROTON BREMSSTRAHLUNG MEASUREMENTS. Mason, David L. (Oak Ridge National Lab., Tenn.). Aug. 1968. Contract W-7405-eng-26. 100p. Dep. CFSTI.

Thesis. Submitted to Univ. of Florida, Gainesville.

Proton-proton bremsstrahlung cross sections were measured for proton energies of 47, 62, and 65 MeV. Although the measurements were not of sufficient accuracy to distinguish between theoretical cross sections calculated using various potentials it appears that the Bryan-Scott potential agrees best with the experimental data. This indicates that a momentum-dependent potential is necessary to describe the nucleon-nucleon interaction. (J.W.R.)

50277 (PPAR-1) MEASUREMENT OF THE BRANCHING RATIO $K_L \rightarrow \gamma\gamma/K_L \rightarrow 3\pi^0$. Banner, M.; Cronin, J. W.; Liu, J. K.; Pilcher, J. E. (Princeton Univ., N. J. Palmer Physical Lab.). Aug. 12, 1968. Contracts AT(30-1)-2137; N0014-67-A-0151-0001. 14p. Dep. CFSTI.

The branching ratio $(K_L \rightarrow \gamma\gamma)/K_L \rightarrow 3\pi^0)$ was measured to be $(2.24 \pm 0.28) \times 10^{-3}$. Combined with a recently reported branching ratio $(K_L \rightarrow 3\pi^0)/(K_L \rightarrow$ all modes) = 0.209 ± 0.011, $(K_L \rightarrow \gamma\gamma)/(K_L \rightarrow$ all modes) was found to be $(4.68 \pm 0.64) \times 10^{-4}$. (auth)

50278 TOTAL CROSS SECTION FOR PHOTOPRODUCTION OF HADRONS ON PROTONS UP TO 5 GeV. Hilpert, H. G. (Technische Hochschule, Aachen); Schnackers, H.; Weber, H.; (and others). Phys. Lett., 27B: 474-6(Sept. 2, 1968).

The total hadronic γ-proton cross section was measured for photon energies between 0.5 and 5.0 GeV. For this measurement the primary photon energy of photoproduction events in a hydrogen bubble chamber was determined by a counter arrangement. (auth)

50279 DIRECT SEARCH FOR THE DECAY MODE $\eta \rightarrow \pi^+\pi^-\pi^0\gamma$. Arnold, R. (Centre de Recherches Nucleaires, Strasbourg); Paty, M.; Riester, J. L.; (and others). Phys. Lett., 27B: 466-7(Sept 2, 1968).

A systematic search for the decay mode $\eta^0 \rightarrow \pi^+\pi^-\pi^0\gamma$ was made with direct detection of the two charged pions and of the three γ-rays in the Ecole Polytechnique heavy liquid bubble chamber. The branching ratio $R = \Gamma(\eta^0 \rightarrow \pi^+\pi^-\pi^0\gamma)/\Gamma(\eta^0 \rightarrow \pi^+\pi^-\pi^0)$ is found to have an upper limit of 1.7% with 90% confidence level. (auth)

50280 NEUTRON FORM FACTORS FROM QUASI-ELASTIC ELECTRON-DEUTERON SCATTERING. Budnitz, R. J.; Appel, J.; Carroll, L.; (and others). (Harvard Univ., Cambridge, Mass.). Phys. Rev., 173: 1357-90(Sept. 25, 1968).

The differential cross section for quasi-elastic electron-deuteron scattering was measured at the Cambridge Electron Accelerator in the four-momentum-transfer region from 7 to 115 F^{-2} f[0.27 to 4.47$(BeV/c)^2$]. The method used involved a coincidence between scattered electrons and recoiling protons. Electrons without a high-energy proton in coincidence were assumed to be due to a neutron interaction. The impulse approximation as developed by Durand and McGee was used to extract from the data the ratio of neutron to proton cross sections. Neutron/proton cross-section ratios from deuterium were measured at q^2 = 7, 10, 15, 20, 30, 45, and 70 F^{-2} (at 20°); at q^2 = 15 F^{-2} (at 90°); and at q^2 = 115 F^{-2} (at 29.64°). It is shown that in the low-q^2 region there are problems of theoretical interpretation. Finally, all available experimental data on the electron-neutron interaction are used to calculate values for the neutron form factors. (auth)

50281 SEARCH FOR NEW PARTICLES PRODUCED BY HIGH-ENERGY PHOTONS. Barna, A.; Cox, J.; Martin, F.; Perl, M. L.; Tan, T. H.; Toner, W. T.; Zipf, T. F.; Bellamy, E. H. (Stanford Univ., Calif.). Phys. Rev., 173: 1391-1402(Sept. 25, 1968).

A search for new particles which might be produced by photons of energy up to 18 GeV is described. No new particles were found. Calculations of the Bethe-Heitler process are described which make it possible to state that this experiment would have detected non-strongly-interacting particles whose mass and life-time lay in a definite range, did they exist. (auth)

50282 EXPERIMENTAL UPPER LIMIT ON THE MAGNETIC MONOPOLE MOMENT OF ELECTRON, PROTONS, AND NEUTRONS, UTILIZING A SUPERCONDUCTING QUANTUM INTERFEROMETER. Vant-Hull, Lorin L. (Ford Scientific Research Staff, Newport Beach, Calif.). Phys. Rev., 173: 1412-13(Sept. 25, 1968).

A superconducting quantum interferometer (magnetic flux sensitivity ~10^{-17} Wb) is shown to be capable of directly detecting magnetic charge, in particular Dirac's quantized magnetic monopoles (magnetic flux = h/e = 4×10^{-15} Wb). In samples free of Dirac monopoles, div B was determined to be less than 1.2×10^{-14} Wb kg, while the magnetic charge of the neutron and of the proton (relative to the electron) were found to be less than 10^{-26} Dirac monopole per nucleon. The magnetic charge of the electron itself was measured to be less than 4×10^{-24} Dirac monopole. (auth)

50283 WIDE-ANGLE ELECTRON-POSITRON PAIR PRODUCTION. Cohen, K. J.; Homma, S.; Luckey, D.; Osborne, L. S. (Massachusetts Inst. of Tech., Cambridge). Contract AT(30-1)-2098. Phys. Rev., 173: 1339-56(Sept. 25, 1968).

The yield of wide-angle electron-positron pairs was measured at the Cambridge Electron Accelerator for $\gamma + C \rightarrow e^+ + e^- + C$ to test the validity of quantum electrodynamics (QED). Symmetric and asymmetric pairs were detected simultaneously, and the interference between the Bethe-Heitler and the Compton matrix elements was measured. Both the angle and the energy of each particle of a pair were measured. One particle was measured with a magnetic spectrometer, using a differential gas Cerenkov counter and shower counters to identify the electron. The other particle of the pair was measured with an array of lead-glass Cerenkov counters. Data were taken at machine energies of 3.0 GeV and 4.14 GeV, and cover an e^+e^- invariant mass range 250-650 MeV/c^2. This experiment agrees with QED and the results of Asbury et al., and disagrees with the results of Blumenthal et al. The measured interference term is larger than predicted by a model using a ρ-dominated virtual Compton term. (auth)

Weak

Refer also to abstract 50342.

50284 (ORO-2504-119) A MEASUREMENT OF THE LONGITUDINAL COMPONENT OF MUON POLARIZATION IN $K_{\mu 3}$ DECAY. Technical Report No. 789. Burris, Richard W. (Maryland Univ., College Park. Dept. of Physics and Astronomy). Aug. 1968. Contract AT(40-1)-2504. 76p. Dep. CFSTI.

The longitudinal component of muon polarization in the decay $K^+ \rightarrow \mu^+ + \pi^0 + \nu$ was measured using a counter-controlled spark chamber array. The K^+ rate was maximized by using a momentum analyzed beam without mass separation. (J.W.R.)

50285 (PPAR-2) MEASUREMENT OF THE BRANCHING RATIO $K_L \rightarrow 2\pi^0/K_L \rightarrow 3\pi^0$. Banner, M.; Cronin, J. W.; Liu, J. K.; Pilcher, J. E. (Princeton Univ., N. J. Palmer Physical Lab.). Aug. 14, 1968. Contracts AT(30-1)-2137; N0014-67-A-0151-0001. 18p. Dep. CFSTI.

The branching ratio $(K_L \rightarrow 2\pi^0)/(K_L \rightarrow 3\pi^0)$ was measured to be $(4.6 \pm 1.1) \times 10^{-3}$. Combined with a recently reported branching ratio $(K_L \rightarrow 3\pi^0)/(K_L \rightarrow$ all modes) = (0.209 ± 0.011), it was found

that $(K_L \rightarrow 2\pi^0)/(K_L \rightarrow \text{all modes}) = (0.96 \pm 0.23) \times 10^{-3}$, and $|\eta_{00}| = (2.3 \pm 0.3) \times 10^{-3}$. (auth)

50286 SEARCH FOR TIME-PARITY VIOLATION IN THE BETA DECAY OF POLARIZED NEUTRONS. Erozolimsky, B. G.; Bondarenko, L. N.; Mostovoy, Yu. A.; Obinyakov, B. A.; Zacharova, V. P.; Titov, V. A. (Kurchatov Inst. of Atomic Energy, Moscow). Phys. Lett., 27B: 557-9(Sept. 30, 1968).

The angular correlation between the directions of escape of an electron and neutrino and neutron spin in the beta decay of polarized neutrons is measured accurately. It is shown that time parity is not violated within the experimental error. The corresponding phase difference between the beta-decay constants g_A and g_V is $\theta = 178.7 \pm 1.3$ degrees. (auth)

50287 DETERMINATION OF THE $K^+_{\mu 3}/K^+_{e3}$ BRANCHING RATIO AND THE SEPARATE K^+_{l3} DECAY RATES. Eichten, T. (Technische Hochschule, Aachen); Haidt, D.; Schultze, K.; (and others). Phys. Lett., 27B: 586-9(Sept. 30, 1968).

A sample of K^+ mesons stopped in the CERN 1.1 m^3 heavy liquid bubble chamber is used to determine the K^+_{l3} decay rates. The value 0.604 ± 0.022 was found for the $K^+_{\mu 3}/K^+_{e3}$ branching ratio, and from this a mean value for $\xi = f_-/f_+$ of -0.6 ± 0.2 was deduced. The separate $K_{\mu 3}/\tau$ and K_{e3}/τ branching ratios were found to be 0.510 ± 0.017 and 0.846 ± 0.021, respectively. (auth)

Strong (Baryon-Induced)

Refer also to abstract 50526.

50288 (JEN-193-DF/I-57) HEAVY HYPERFRAGMENTS PRODUCED BY 800-MeV/c K^- IN NUCLEAR EMULSIONS. Doporto Laguia, Marcial P. (Junta de Energia Nuclear, Madrid (Spain). Division de Fisica). 1967. 18p. (In Spanish). Dep.

A statistical and phenomenological survey of nearly 1200 heavy hyperfragments produced by the interaction of 800 MeV/c K^- with the heavy nuclei of Ilford K5 emulsion is presented. The emulsion was exposed in Berkeley. The variation of a long list of parameters dealing with both the production and disintegration of the hyperfragments, with the size of the primary interaction is given. The results can be divided into those dealing with the production and the disintegration of the hyperfragments. It is shown that present day Monte Carlo procedures do not reproduce the production characteristics with any great fidelity. It is thought that this is due to lack of detail in the input parameters. An asymmetry in the angular distribution of the disintegration products of the hyperfragments is confirmed by measurements in two other stacks, one irradiated with stopping K^- and the other with 6 GeV/c K^-. It is shown that this asymmetry can be explained if the lifetime of the heavy hyperfragment is of the order of 10^{-11} seconds. This last result implies that the lifetime of the unbound Λ^0 particle is reduced by a factor of twenty when it is bound to heavy nuclear matter. (auth)

50289 (ORO-2504-123) LOW ENERGY Λ-PROTON ELASTIC SCATTERING. Technical Report No. 846. Sechi-Zorn, B.; Kehoe, B.; Twitty, J.; Burnstein, R. A. (Maryland Univ., College Park. Dept. of Physics and Astronomy). July 1968. Contract AT(40-1)-2504. 26p. Dep. CFSTI.

The cross sections for (Λ,p) elastic scattering with Λ momenta in the interval 110 to 330 MeV/c have been measured. The results are based on 224 scattering events found in a sample of 95,600 Λ hyperons observed in an exposure of the 81 cm Saclay hydrogen bubble chamber to a stopping K^- beam. These cross sections are analyzed in terms of effective range theory. A wide spectrum of solutions in this formalism give acceptable agreement with the data. (auth)

50290 TWO-PRONG INTERACTION BY $\pi^+ + p$ COLLISIONS AT 2.77 BeV/c. Yamamoto, S. S. (Brookhaven National Lab., Upton, N. Y. Univ. of Massachusetts, Amherst); Rahm, D. C. Contract AT(30-1)-3651. Phys. Rev., 173: 1302-6(Sept. 25, 1968).

Two-prong interactions by 2.77-BeV/c π^+ on protons were investigated. The elastic scattering angular distribution shows an elastic exponential forward peak as well as two diffraction minima. The final state $\pi^+ + p + \pi^0$ involves significant production of ρ^+, N^{*+}, and N^{*++}. The final state $\pi^+ + \pi^+ + n$ shows no T = 2 dipion resonance formation. Significant production of $\eta + N^{*++}$ is observed where the η decays into neutral final states. (auth)

50291 PION PRODUCTION AND ELASTIC SCATTERING IN ANTIPROTON-PROTON COLLISIONS AT 6.94 BeV/c. Ferbel, T.; Johnson, J. A.; Kraybill, H. L.; Sandweiss, J.; Taft, H. D. (Yale Univ., New Haven. Brookhaven National Lab., Upton, N. Y.). Contract AT(30-1)-2726. Phys. Rev., 173: 1307-14(Sept. 25, 1968). (YALE-2726-519).

A study was made of nonstrange $\bar{p}$-p interactions observed in 7000 pictures of the 80-in. Brookhaven National Laboratory hydrogen bubble chamber exposed to an antiproton beam with a momentum of 6.94 BeV/c. The total cross section was measured to be 58.7 ± 2.8 mb, and the elastic interaction cross section 14.2 ± 1.2 mb. The elastic differential cross section for four-momentum transfers $(-t) \leq 0.3$ $(BeV/c)^2$ is well described by the exponential form $d\sigma_{el}/dt = (d\sigma/dt)_{t=0} e^{bt}$, where $b = 13.1 \pm 1.1$ $(BeV/c)^{-2}$. The single-pion production cross section is 4.0 ± 0.9 mb. This channel proceeds 70% through resonance formation. N*(1238) isobar and anti-isobar formation dominates pion production in four- and six-pronged events; the double-isobar formation cross section in the final state $p\pi^+p\pi^-$ is 1.35 ± 0.2 mb. Isobar production was observed to be consistent with the predictions of a dominant one-particle-exchange process. The pion-annihilation process, which has a cross section of 25 ± 5 mb, shows substantial pion resonance formation. (auth)

50292 ELASTIC SCATTERING AND SINGLE-PION PRODUCTION IN PROTON-PROTON INTERACTIONS AT 6.92 BeV/c. Alexander, G. (Weizmann Inst. of Science, Rehovoth, Israel); Carmel, Z.; Eisenberg, Y.; (and others). Phys. Rev., 173: 1322-9(Sept. 25, 1968).

Elastic scattering and single-pion production in pp collisions at 6.92 BeV/c were studied in the BNL 80-in. hydrogen bubble chamber. Partial cross sections for the different final states are given. The reaction $pp \rightarrow nN_{1238}^{*}(p\pi^+)$ with $\sigma = 1.9 \pm 0.3$ mb is analyzed and is in agreement with the modified one-pion-exchange model. Single-pion production can be explained as due mainly to two channels: (a) $pp \rightarrow N_{1238}^{*}(p\pi^+)n$, and (b) $pp \rightarrow p(n\pi^+)$ or $pp \rightarrow p(p\pi^0)$, where the $(n\pi^+)$ and $(p\pi^0)$ pairs are in an $I = \frac{1}{2}$ state. (auth)

Strong (Meson-Induced)

Refer also to abstract 50552.

50293 (JINR-P1-4003) π^+p ELASTIC SCATTERING AT 2.34 GeV/c π^+ MESON MOMENTUM. Angelov, N.; Gramenitskii, I. M.; Kanazirski, Kh.; Moiseev, A. M.; Tikhonova, L. A.; Fenyuk, A. B.; Shafranov, M. D. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of High Energy). 1968. 13p. (In Russian). Dep.

Data are given on elastic π^+p-scattering at 2.34 GeV/c momentum. Total cross sections and the differential cross section dip at small momentum transfer were determined using 5500 events of $\pi^+p \rightarrow \pi^+p$ interactions. Comparisons were made of the published data for π^+ mesons with identical momentum magnitudes. (tr-auth)

50294 (SLAC-PUB-480) 4π MASS ENHANCEMENTS IN 16-GeV/c π^-p INTERACTIONS. Ballam, J.; Brody, A. D.; Chadwick, G. B.; Guirragossian, Z. G. T.; Johnson, W. B.; Leith, D. W. G. S.; Pickup, E. (Stanford Linear Accelerator, Center, Calif.). Aug. 1968. 12p. (CONF-680809-26). Dep. CFSTI.

From 14th International Conference on High Energy Physics, Vienna, Austria.

In a 16 GeV/c π^-p experiment production of two 4π resonances at 1250 and 1700 MeV were observed whose predominant decay modes are $\omega^0\pi^-$ and $\rho^0\rho^-$ respectively. (auth)

50295 (UCRL-18321) STUDY OF ω AND φ PRODUCTION IN K^+p INTERACTIONS AT 4.6 AND 9.0 GeV/c. Alexander, G.; Firestone, A.; Fu, C.; Goldhaber, G.; Pignotti, A. (California Univ., Berkeley. Lawrence Radiation Lab.). July 1968. Contract W-7405-eng-48. 48p. (CONF-680809-29). Dep. CFSTI.

From 14th International Conference on High Energy Physics, Vienna, Austria.

Results on the ω and φ production in $K^+p \rightarrow K^+\omega p$ and $K^+p \rightarrow K^+\varphi p$ interactions at incident momenta of 4.6 and 9.0 GeV/c are presented. There is no statistically significant evidence for Kω or Kφ resonance production. The 437 $K^+\omega p$ events at 9 GeV/c are analyzed in terms of a multiperipheral Regge model on the entire Dalitz plot. The events have been assigned to the various peripheral diagrams on the basis of criteria in the four-momentum transfers. A satisfactory description of the data has been obtained on the basis of diagrams involving Pomeranchuk and meson exchanges. (auth)

50296 (UCRL-18323) K^+p INTERACTIONS NEAR 1 GeV/c. Bland, R. W.; Goldhaber, G.; Hall, B. H.; Kadyk, J. A.; Seeger, V. H.; Trilling, G. H.; Wohl, C. G. (California Univ., Berkeley. Lawrence Radiation Lab.). July 1968. Contract W-7405-eng-48. 25p. (CONF-680809-30). Dep. CFSTI.

From 14th International Conference on High Energy Physics, Vienna, Austria.

An analysis of film obtained in an exposure of the LRL 25-inch bubble chamber to a separated K^+ beam at several momenta between 0.860 and 1.58 BeV/c is presented. The behavior of the elastic and inelastic cross sections, details of the elastic scattering, and the inelastic processes are discussed. (W.H.K.)

50297 (UCRL-18411) EXCHANGE AMPLITUDE CONTRIBUTIONS TO THE REACTION $K^- + p \rightarrow \Lambda + \pi^0$ NEAR 1 GeV/c. Louie, James (California Univ., Berkeley. Lawrence Radiation Lab.). Aug. 1968. Contract W-7405-eng-48. 78p. Dep. CFSTI.

Thesis.

The reaction $K^- + p \rightarrow \Lambda + \pi^0$ was analyzed in terms of direct channel resonances and background exchange amplitudes, making fits to experimental angular distributions, Λ polarizations, and $\Lambda\pi^0$ cross sections over the center-of-mass energy range 1700 to 1850 MeV. The primary aim was to investigate the nature of the background terms, using K* and nucleon crossed-channel exchanges, in the scattering amplitude required to fit our data. Previous J^P assignments were confirmed for $Y_1^*(1660)$, $Y_1^*(1770)$, and $Y_1^*(2030)$, and branching ratio products $x_{\bar{K}N}x_{\Lambda\pi}$ for these three resonances were presented. A mass and width for $Y_1^*(1770)$ were also determined. The data do not show much sensitivity to the presence of $Y_1^*(1910)$. The assumption of simple background exchange terms alone did not seem to be sufficient to fit the data. Modifications to these terms were made, producing reasonable fits. Effects due to the assumptions of the absorption model were also considered. (auth)

50298 HYPERFRAGMENT PRODUCTION AND DECAY AND THE NON-MESIC ABSORPTION RATE FOR STOPPING K^- MESONS IN NEON. Cohn, H. O. (Oak Ridge National Lab., Tenn.); McCulloch, R. D.; Bugg, W. M.; Condo, G. T.; Garrett, N.; Tucker, L. M. Phys. Lett., 27B: 527-9(Sept. 16, 1968).

In a bubble chamber study of stopping K^- + neon interactions, the hyperfragment production probability (trapped Λ events) following K^- absorption was measured to be 9.5 ± 3%. The mesic decay probability for these hyperfragments was less than 9% and the multi-nucleon or non-mesic K^- absorption probability was 22 ± 4%. (auth)

50299 TOTAL AND DIFFERENTIAL CROSS SECTIONS IN 10 GeV/c K^-p INTERACTIONS. Aderholz, M. (Technische Hochschule, Aachen); Deutschmann, M.; Keppel, E.; (and others). Nucl. Phys., B7: 111-20(1968).

For 10 GeV/c K^-p interactions, the total and differential cross sections for elastic scattering and for the eight most frequent quasi two-body reactions are presented. The combined cross sections of these eight inelastic reactions is 4.8% of the total K^-p cross section at 10 GeV/c. In the differential cross sections, pronounced forward peaks are observed with shapes about the same as that for elastic scattering, but no backward peaks are found. Dips in the differential cross sections are discussed. (auth)

50300 DETERMINATION OF THE NEUTRON–NEUTRON SCATTERING LENGTH FROM THE REACTION $\pi^- + d \rightarrow 2n + \gamma$. Nicholson, J. P.; Butler, P. G.; Cohen, N.; James, A. N. (Univ. of Liverpool). Phys. Lett., 27B: 452-5(Sept. 2, 1968).

The photon energy spectrum from the reaction $\pi^- + d \rightarrow 2n + \gamma$ at zero energy was measured by pair spectrometer using spark acoustic spark chambers to locate the pair electron tracks. From the shape of the spectrum the neutron-neutron scattering length was determined to be $a_{nn} = 13.1^{+3.4}_{-1.4}$ fm. The probability of existence of a bound state of two neutrons was calculated to be less than 5×10^{-9}. (auth)

50301 NON-MESONIC DECAY OF HELIUM HYPERNUCLEI. Coremans, G. (Univ. Libre, Brussels); Sacton, J.; Davis, D. H.; Allen, J. E.; Fishwick, A. Univ. Brux., Inst. Phys., Bull., No. 35, 18p.(Apr. 1968).

The non-mesonic decays of hypernuclei which emit two charged particles were analyzed. The events were produced in absorptions of K^- mesons at rest in nuclear emulsions. From a knowledge of the numbers of π^- -mesonic decays of various species found from the same sample of K^- meson capture stars and also the non-mesonic decay parameters deduced from $_\Lambda He^4$ decays in a helium bubble chamber, an attempt was made to determine the rates of the different non-mesonic decay modes of the $_\Lambda He^5$ hypernucleus. Some properties of the $_\Lambda He^5 \rightarrow H^1 H^3$ n process are established. (auth)

50302 π^-p ELASTIC SCATTERING AT 2.26 GeV/c. Reynolds, B. G.; Kimel, J. D.; Albright, J. R.; Bradley, R. H.; Brucker, E. B.; Harrison, W. C.; Harms, B. C.; Lannutti, J. E.; Sims, W. H.; Wieckowicz, R. P. (Florida State Univ., Tallahassee). Phys. Rev., 173: 1403-11(Sept. 25, 1968).

The elastic scattering of negative pions on protons at 2.26 GeV/c was studied using the Lawrence Radiation Laboratory 72-in. hydrogen-filled bubble chamber. The elastic scattering cross section is found to be 8.91 ± 0.24 mb. The forward diffraction peak is well fitted by an exponential in the square of the four-momentum transfer, and the slope is found to be 8.8 ± 0.1 GeV^{-2}. The differential cross section is parametrized in terms of three models: optical, strong-absorption, and two-slope. It is found that the two-slope model affords the best description of the data and also does very well in predicting the polarization data of other experiments. The best-fit parameters for all three models are given. In addition, the amplitudes associated with the best fits are given for the strong-absorption and the two-slope models. (auth)

50303 ON $K_L - K_S$ REGENERATION IN COPPER. Boehm, A.; Darriulat, P.; Grosso, C.; Kaftanov, V.; Kleinknecht, K.; Lynch, H. L.; Rubbia, C.; Ticho, H.; Tittel, K. (CERN, Geneva). Phys. Lett., 27B: 594-8(Sept. 30, 1968).

The transmission regeneration amplitude after a thick copper block was measured. The quantity $|f(0) - \bar{f}(0)|/k$ varies from 20.0 ± 1.4 mb at 2.75 GeV/c to 13.6 ± 1.2 mb at 7.25 GeV/c. Results are in agreement with optical model calculations in which real and imaginary parts of the amplitudes for single nucleon scattering are determined from forward dispersion relations and total cross sections. (auth)

50304 K^+n CHARGE EXCHANGE REACTION AT 3 GeV/c. Goldschmidt-Clermont, Y. (CERN, Geneva); Henri, V. P.; Jongejans, B.; (and others). Phys. Lett., 27B: 602-4(Sept. 30, 1968).

About 100,000 pictures, with an average of ~12 K^+ per picture, taken in the 81 cm Saclay deuterium bubble chamber exposed to a separated 3 GeV/c K^+ beam were analyzed for the reaction $K^+d \rightarrow K^0pp$ in the 1-prong V^0 and 2-prong V^0 topologies. 214 such events were found allowing a determination of the differential cross section. A comparison with the prediction of Rarita and Schwarzschild yields reasonable agreements; in particular a large real part is inferred for the amplitude for the reaction $K^+n \rightarrow K^0p$. (auth)

50305 STUDY OF THE Λ–N SYSTEM IN LOW-ENERGY Λ-p ELASTIC SCATTERING. Alexander, G. (Weizmann Inst. of Science, Rehovoth, Israel); Karshon, U.; Shapira, A.; Yekutieli, G.; Engelmann, R.; Filthuth, H.; Lughofer, W. Phys. Rev., 173: 1452-60(Sept. 25, 1968).

A study was made of 378 Λ-p elastic scattering events in the incident-momentum region 120 to 320 MeV/c. Differential and total cross sections were measured in several momentum intervals and found to be consistent with predominantly S-wave scattering. No significant indication for the existence of a low-energy Λ-p resonance was found. Using the effective-range approximation, the four scattering parameters a_s, a_t, r_s, and r_t were evaluated with and without further assumptions on the Λ-p interaction properties. Best values obtained from the four-parameter fit were $a_s = -1.8$, $a_t = -1.6$, $r_s = 2.8$, and $r_t = 3.3$ F. A likelihood-function mapping procedure is used to describe the large and strongly correlated errors of these values. (auth)

50306 REACTIONS $K^-p \rightarrow \Sigma^\pm\pi^\pm$ AT 4.07 AND 5.47 GeV/c. Loos, J. S.; Kruse, U. E.; Goldwasser, E. L. (Univ. of Illinois, Urbana). Phys. Rev., 173: 1330-8(Sept. 25, 1968).

Experimental results, based on a hydrogen-bubble-chamber exposure, are reported for the reactions (1) $K^-p \rightarrow \Sigma^+\pi^-$ and (2) $K^-p \rightarrow \Sigma^-\pi^+$. In the experiment, K^- track lengths equivalent to 0.95 μb per event at 4.07 GeV/c and 0.27 μb per event at 5.47 GeV/c were analyzed. The cross sections at 4.07 and 5.47 GeV/c, respectively, are 107 ± 27 and 84 ± 14 μb for reaction (1), and 8 ± 5 and 2 ± 1 μb for reaction (2). The dominant feature of reaction (1) is a peripheral peak in the center-of-mass production angular distribution. Differential cross sections are presented for the pheripheral region, and a comparison with the Regge model of Sarma and Reeder is made. Because of the statistics of this experiment, only crude estimates can be given for the extreme backward (antiperipheral) differential cross section for these reactions. (auth)

50307 DOUBLE CHARGE EXCHANGE OF π-MESONS IN PHOTOEMULSION IN THE 50 to 176 MeV ENERGY RANGE. Batusov, I. A.; Bunlatov, S. A.; Ionita, G.; Lozneanu, E.; Mihul, V.; Sidorov, V. M.; Yarba, V. A. An. Stiint. Univ. Al. I. Cuza Iasi, Sect. Ib. Fiz., 13: 1-3(1967).

Measurements of the cross section of the double charge exchange of π^--mesons were made in photoemulsion in the 50–176 MeV energy range. The energy and angular distributions of secondary π^+-mesons were also investigated. (Rom. Sci. Abstr.) (auth)

50308 CHARGE-EXCHANGE SCATTERING OF K^+ MESONS FROM BERYLLIUM AT 0.97 BeV/c. Gezelter, J. (Princeton Univ., N. J.); Salmon, G. L.; Murphy, F. V.; O'Neill, G. K.; Grismore, R. Phys. Rev., 173: 1315-22(Sept. 25, 1968).

$K^+ + n \rightarrow K^0 + p$ scattering at an incident K^+ laboratory momentum of 0.97 BeV/c was studied in a spark chamber containing beryllium targets. The angular distribution of the scattered K^0's was measured. A background-subtraction procedure based on a study of simulated events generated by Monte Carlo computer tech-

niques was used to separate the true charge exchanges from pion-production events. The c.m. system angular distribution inferred for K^+ mesons charge-exchange scattering from free neutrons is presented. The angular distribution was subjected to a phase-shift analysis, and six sets of solutions using real S- and P-wave phase shifts are given for the zero-isospin state. Plots are presented of contour projections of the least-squares fitting function in phase-shift space. (auth)

50309 DIFFRACTION-TYPE INTERACTIONS IN THE EMULSION OF 7 AND 17-GeV/c-MOMENTUM π^- MESONS. Gombosi, Eva (Central Research Inst. for Physics, Budapest). Magy. Fiz. Foly., 16: 189-261(1968). (In Hungarian).

The characteristics of events induced by 7 and 17 GeV/c π^- mesons, selected on the basis of πN interactions were determined, using the laboratory, πN center of mass, and $\pi\pi$ center of mass systems. The angular momentum distribution of secondary particles, and the correlation between the mean transversal pulse, the number and mass of secondary particles, and the energy of the primary particles were determined. The results indicated that in most cases, the low-multiplicity interactions exhibit a peripheral character, i.e., the primary meson interacts with the pion cloud of the target nucleon. The high-multiplicity events correspond to central-core collisions. On the basis of the inelastic cross section, the radius of the nucleon's core was found to be $r_{core} \leq 0.7 \times 10^{-13}$ cm. Examination of the $\pi^-p \rightarrow p\pi^-(k\pi^0)$ and $\pi^-p \rightarrow n\pi^+\pi^-(k'\pi^0)$ peripheral πN interactions showed that in most of these events, the primary pion is subjected to a quasielastic diffraction scattering at a virtual pion of the target nucleus. In about 25% of these events, charge-exchange type diffraction scattering takes place. The lower and upper limits of the mean free path of interaction for diffusion dissociation was found to be (555 ± 131) m and (61 ± 5) m (lower), (1600 ± 800) m and (300 ± 83) m (upper), for 7 and 17 GeV, respectively. (Doctoral dissertation, 119 references). (TTT)

Particle Interactions and Properties (Theoretical)

Refer also to abstract 50491.

General

50310 (PPAR-4) EXTRACTING MATRIX ELEMENTS FROM THE LEE-DALITZ PLOT. Frankel, Sherman; Van Dyck, Olin (Princeton-Pennsylvania Accelerator, Princeton, N. J.). Aug. 17, 1968. Contract AT(30-1)-2137. 25p. Dep. CFSTI.

Using the orthogonal functions $\lambda^m_n(\alpha,\beta)$ to express the density of points observed on a "Lee-Dalitz" Plot, it is shown that the experimentally observed distribution is $W(\alpha,\beta) = \Sigma a^n_m g^{nl}_{mk} \lambda^l_k(\alpha,\beta)$ where the a^n_m are the coefficients of the theoretical distribution $\Sigma a^n_m \lambda^n_m(\alpha,\beta)$ and the g^{nl}_{mk} are exact correction factors that can be simply extracted from Monte Carlo calculations. Discussion of the sources of the g^{nl}_{mk} and a simple prescription for their determination are given. The value to the experimentalist of using orthogonal functions in searching for nonstatistical errors in the data is illustrated with an example from the current literature. Finally we show that the a^n_m may be extracted from the ordinary Dalitz Plot without recourse to the Lee transformation $(\rho,\theta) \rightarrow (\alpha,\beta)$. In this case the observed distribution is $W(\rho,\theta) = \Sigma a^n_m G^{nl}_{mk} \lambda^l_k(\rho,\theta)$ where the G^{nl}_{mk} are obtained in the same manner as the g^{nl}_{mk}. The extraction methods described herein are exact and general and are applicable for any orthogonal function description $Y^m_l(\theta,\varphi)$, $P^0_l(\cos\theta)$ etc. (auth)

50311 ON THE $\pi^+ - \pi^0$ MASS DIFFERENCE. Kokott, T.; Pietschmann, H.; Rollnik, H. (Univ., Bonn). Z. Phys., 216: 65-7(1968).

The $\pi^+ - \pi^0$ mass difference is calculated from spectral function sum rules with finite widths of ρ and A_1. The deviation from the zero width approximation is found to be small. (auth)

50312 EVERY ELEMENTARY PARTICLE HAS ITS FOUR KINDS OF ISOBARS. Ono, Ken-ichi (Tokyo Univ.). Sci. Pap. Coll. Gen. Educ., Univ. Tokyo, 18: No. 1, 13-18(June 1968).

It is stated that elementary particles can rotate at an arbitrary velocity and can suffer any deformation means to be converted to another species of elementary particles. It is postulated that all natural laws are invariant under both TT_0 and PP_0; where PP_0 means complete space reflection of both the behaviors and the internal structures of elementary particles, and TT_0 means complete time reversal. From this postulate, the existence of four kinds of isobars for each elementary particle is deduced. (L.B.S.)

50313 ADVANCES IN PARTICLE PHYSICS. VOLUME I. Cool, R. L.; Marshak, R. E. (eds). An Interscience Series. New York, John Wiley and Sons, Inc., 1968. 503p.

Separate abstracts were prepared for the five review articles presented. (L.B.S.)

For abstracts of individual papers see: 50344, 50345, 50431, 50432, and 50496.

50314 PROPAGATION FUNCTIONS, RECALIBRATION CONSTANTS, AND THE ELEMENTARY OR COMPOUND CHARACTER OF PARTICLES. PART II. Stihi, M.; Visinescu, M. (Inst. of Atomic Physics, Bucharest). Stud. Cercet. Fiz., 20: 145-75(1968). (In Rumanian).

Feynman diagrams corresponding to the electron scattering on charged "scalar mesons" of the perturbation theory were examined while studying the form factors of three-field systems. In contrast to electrons, mesons may be involved in strong interactions, complicating the coupling with the electromagnetic field. The Omnes function was derived for the elastic region, neglecting the inelastic effects. Solution of this function requires knowledge of the scattering phase. The relation of analytical properties of the propagation functions and form factors to the elementary or compound character of the particles was studied. The latter were assumed to possess a scalar nature, thus avoiding the otherwise less important complications due to consideration of spin, isospin, etc. The interaction between "scalar nucleons," their antiparticles and "scalar mesons" were reviewed, studying the nucleon-antinucleon elastic scattering wave and taking into account the possible existence of an intermediate meson state. (TTT)

50315 THEORY OF CURRENTS: HOW TO BREAK THE SYMMETRY. Sugawara, Hirotaka (Univ. of Chicago). Phys. Rev. Lett., 21: 772-5(Sept. 9, 1968).

A theory of currents is extended to include the symmetry-breaking effect without introducing extra currents. It is a non-spherical top in the internal space and found to be consistent with the mass-mixing model. (auth)

50316 LOW-ENERGY-THEOREM APPROACH TO SINGLE-PARTICLE SINGULARITIES IN THE PRESENCE OF MASSLESS BOSONS. Jackiw, R. (CERN, Geneva. Harvard Univ., Cambridge, Mass.); Soloviev, L. Phys. Rev., 173: 1485-97(Sept. 25, 1968).

By the use of low-energy theorems, which follow from gauge invariance and analyticity assumptions, the nature of the single-particle singularity of a meson propagator in the presence of the known massless bosons, photons and gravitons was determined. In addition to regaining the well-known results for covariant gauges in electrodynamics, new results are presented for covariant gauges in gravity theory, and for radiation gauges in both electrodynamics and gravity theory. The gauges in which no infrared singularities are present are found: For covariant electrodynamics it is of course the Yennie gauge; for covariant gravity theory a similar gauge is given. In radiation gauges it is shown that Schwinger's new gauge has this desirable property for photons, and an analogous gauge is constructed for gravitons. It is established that in these gauges the single-particle singularity of the meson propagator becomes a simple pole. (auth)

50317 ANALYTIC PROPERTIES OF CURRENT-ALGEBRA VERTEX FUNCTIONS. Bander, Myron (Univ. of California, Irvine). Phys. Rev., 173: 1568-72(Sept. 25, 1968).

An expansion of the vector-current vertex is obtained in terms of the Joos spinor amplitudes. As these are free of kinematic singularities, one can remove them from the vertex that enters into the algebra-of-currents sum rules. If one assumes unsubtracted dispersion relations for the resulting form factors, then the sum rules can be cast into a form which involves Bessel transforms of these form factors. (auth)

50318 SOURCES AND MAGNETIC CHARGE. Schwinger, Julian (State Univ. of New York, Stony Brook). Phys. Rev., 173: 1536-44(Sept. 25, 1968).

A beginning is made on a phenomenological reconstruction of the theory of magnetic charge. The concept is introduced by reference to a new kind of photon source. It is shown that photon exchange between different source types is relativistically invariant. The space-time generalization of this coupling involves an arbitrary vector. The only way to remove a corresponding arbitrariness of physical predictions is to recognize the localization of charge and impose a charge quantization condition. The consideration of particles that carry both kinds of charge loosens the charge restrictions. The great strength of magnetic attraction indicated by $g^2/4\pi = 4(137)$ suggests that ordinary matter is a magnetically neutral composite of magnetically charged particles that carry fractional electric charge. There is a brief discussion of such a magnetic model of strongly interacting particles, which makes contact with

empirical classification schemes. Additional remarks on notation, and on the general nature of the source description, are appended. (auth)

Electromagnetic

Refer also to abstract 50415.

50319 (DESY-68/38) THE INFLUENCE OF THE (33) RESONANCE ON THE DISINTEGRATION OF THE DEUTERONS. Hasselmann, Dieter (Physikalisches Staatsinstitut, Hamburg (West Germany)). July 1968. 46p. (In German). Dep.

The influence of the N*-(33)-resonance on photodisintegration of the deuteron at 300 MeV is studied. The covariant model presented gives satisfactory agreement with experiment, especially for the total cross section, but the main qualitative features of the differential cross sections are also reproduced. It is found that, while the main contribution arises from the NN* intermediate state, the Born terms may not be neglected, interference being quite important. The results depend strongly on the deuteron vertex function at high momentum transfers. (auth)

50320 (NYO-2262-TA-191) SOFT PION SUMMATIONS AND A CHIRAL CANCELLATION. Fried, H. M. (Brown Univ., Providence, R. I. Dept. of Physics). Aug. 1968. Contract AT(30-1)-2262. 20p. Dep. CFSTI.

A method of summing a portion of the virtual soft pion dependence for hadronic processes, taking pion correlations partially into account, is applied to the nucleon electromagnetic form factors. No damping at large momentum transfer is found, but rather a tendency toward enhancement which is removed by a delicate cancellation generated by the chiral nature of the soft pion–nucleon interaction. (auth)

50321 (UCRL-18377) APPLICATIONS OF THE LORENTZ GROUP TO REGGE POLE ANALYSIS OF PION PHOTOPRODUCTION. Dash, Jan William (California Univ., Berkeley. Lawrence Radiation Lab.). July 20, 1968. Contract W-7405-eng-48. 65p. Dep. CFSTI.

Applications of Lorentz invariance and Regge pole theory to the phenomenological study of photoproduction of pions from nucleons and nucleon–nucleon scattering are considered. The kinematics for the more general cases having all unequal and nonzero external masses are worked out, and then the limit of equal baryon masses and zero photon mass is taken. The applications of Lorentz symmetry at t = 0 (i.e., conspiracy) are considered, and the photoproduction daughter sequence is obtained through analyticity arguments. The factorization of the photoproduction Regge residues is shown to be consistent with the conspiracy relations in the nucleon–nucleon and pion Compton scattering processes. The high energy pion photoproduction data along with nucleon–nucleon data assuming the existence of an M = 1 pion parity doublet conspiracy are analyzed. The consequences of assuming a square-root type zero or a full zero in the $\pi N\bar{N}$ vertex function are investigated. The possibility of the existence of an M = 1 B-ρ' parity doublet conspiracy is investigated qualitatively through a photoproduction sum rule for the photon isoscalar amplitude, and by requiring consistency between phenomenological fits. Additional experimental tests for an M = 1 B trajectory are proposed. (auth)

50322 PHOTOPRODUCTION AND ELECTROPRODUCTION OF PIONS IN POLARIZED PROTON TARGETS. Zagury, N. (Univ. Catolica, Rio de Janeiro); Teixeira, A. F. F. Notas Fis., Cent. Brasil. Pesqui. Fis., 13: 317-43(1968).

The angular distribution of pions for photoproduction and electroproduction of pions on polarized proton targets is given. Using explicit values for the multipoles this angular distribution was calculated in the case where the energy of the π-N system in their center of mass is 1236 MeV and for momentum transfers equal to zero (photoproduction) and -3, -6 and $-10f^{-2}$ (electroproduction). (auth)

50323 DISPERSION SUM RULE FOR η^0 MESON PHOTOPRODUCTION. Kuraev, E. A.; Lazarenko, L. A. (Inst. of Physics and Tech., Kharkov). Ukr. Fiz. Zh., 13: 1223-4(July 1968). (In Russian).

Superconvergent sum rules ordinarily used for finding the ratio between interaction constants, magnetic moments, and resonances were used for studying photoproduction of η mesons on nucleons. The possible limitations on the variation of the coupling constant $g_{mn\eta}$ were evaluated and the multiple structure of the second meson-nucleon resonance was analyzed. (R.V.J.)

50324 INVARIANT AMPLITUDES AND LOW-ENERGY PHOTON THEOREMS. Conway, P. D. (Princeton Univ., N. J.). Nuovo Cim., 57A: 533-48(Oct. 1, 1968).

The classical Compton theorems for low-energy scattering of photons on pions or nucleons are proved and in addition certain recent results of Choudhury and Freedman derived. The only assumptions are Lorentz and gauge invariance, with of course the usual analyticity properties. Invariant amplitudes are used everywhere and crossing is never employed. Using the same methods, the Kroll-Ruderman theorem for photoproduction and certain superconvergence relations are derived. (auth)

50325 VECTOR-MESON DOMINANCE MODEL OF THE RADIATIVE DECAYS OF BARYONS. Joos, H.; Schildknecht, D. (DESY, Hamburg). Nuovo Cim., 57A: 593-4(Oct. 1, 1968).

The application of the vector-meson dominance model to the radiative decays and possible ρ^0 decay modes of $\Delta(1920)$ and $\Delta(2420)$ is considered. Estimates for $\Gamma(\Delta \rightarrow \rho^0 N)$ and the branching ratio for decay in ρ are obtained. Estimates are also obtained for the photoproduction cross section at resonance energy $\sigma(\gamma N \rightarrow \rho^0 N)$. (L.B.S.)

50326 MESON RESONANCES FROM ELECTRON–POSITRON COLLIDING BEAMS. Celeghini, E. (Istituto Nazionale di Fisica Nucleare, Florence); Gatto, R. Nuovo Cim., 57A: 549-72(Oct. 1, 1968).

Electron-positron colliding beam reactions leading to meson resonant states are discussed together with the subsequent chains of decay processes. A compact formalism is developed for predicting the expected angular correlations and tables are given of the expected angular dependences. Resonant states of vector, axial vector (with both values of charge conjugation), tensor, and scalar type are considered. The possibility of polarized electron-positron beams is considered and the angular dependence given in terms of the degrees of polarization and polarization angles. Consequences of SU_3 are also reviewed. In the Appendix a simple formalism for studying correlations in chains of resonant processes is summarized. (auth)

50327 ISOTOPIC RELATIONS FOR PHOTOPRODUCTION PROCESSES. Dzhrbashyan, V. A. (Inst. of Physics, Erevan). Izv. Akad. Nauk Arm. SSR, Ser. Fiz., 2: 440-2(1967). (In Russian).

The equalities $\sigma(\gamma + d \rightarrow n + N^{*+}) = \sigma(\gamma + d \rightarrow p + N^{*0})$ and $\sigma(\gamma + {}^4He \rightarrow {}^3He + N^{*0}) = \sigma(\gamma + {}^4He \rightarrow {}^3H + N^{*+})$ for the photoproduction cross sections are obtained from the assumption that the γ-quantum is a superposition of states with isospins I = 0 and I = 1. (auth)

50328 POLARIZATION PHENOMENA DURING THE SCATTERING OF ELECTRONS BY PROTONS IN THE HIGH-ENERGY RANGE. Akhiezer, A. I.; Rekalo, M. P. (Physico-Technical Inst., Kiev). Dokl. Akad. Nauk SSSR, 180: 1081-3(June 11, 1968). (In Russian).

Study of the elastic (e + p) scattering with unpolarized particles yielded two combinations of electromagnetic form factors; however, at high momentum, it was found difficult to separate them. On this basis polarization experiments were carried out to determine the charge form factors of protons, analyzing the polarization characteristics of (ep) scattering. The results indicated that for measurement of polarization of recoil protons or of the asymmetry of angular distribution at certain directional polarization vector of the original particle, the form factor may be determined at high momentum; formulas derived previously by the author and collaborators were used for the determination. The method is more effective than determination of cross-sections of unpolarized particles. (TTT)

50329 ABSENCE OF SCALAR GOLDSTONE "PIONS". Deser, S.; Rawls, J. (Brandeis Univ., Waltham, Mass.). Phys. Lett., 27B: 460-2(Sept. 2, 1968).

The minimal electromagnetic coupling generalization of CVC is used to derive the form of its scalar isovector spectrum. To order α^0, the spectrum is shown to be empty (including massless states). Order α properties are discussed. (auth)

50330 LOW-ENERGY THEOREMS FOR THE COMPTON SCATTERING OF THE ISOVECTOR PHOTON FROM SPIN 0 SYSTEMS IN CHIRAL DYNAMICS. Hosoda, Masataka; Ozaki, Kazuhiko (Osaka Univ.). Progr. Theor. Phys. (Kyoto), 40: 183-5(July 1968).

It is shown that the low-energy theorems specifying the exact behavior of the scattering amplitude for the Compton scattering of the isovector photon from spin-0 systems are obtained by a straight forward calculation of Feynman graphs in lowest order. (L.B.S.)

50331 THRESHOLD ELECTROPION PRODUCTION FROM CURRENT ALGEBRA AND PARTIALLY CONSERVED AXIAL-VECTOR CURRENT. Gleeson, A. M. (Syracuse Univ., N. Y.); Gundzik, M. G.; Kuriyan, Jacob G. Phys. Rev., 173: 1708-15 (Sept. 25, 1968).

Threshold electropion production on nucleons, $e + N \rightarrow e + N + \pi$, is studied by current-algebra techniques using the hypothesis of partially conserved axial-vector current, which have proved useful in describing low-energy meson-baryon elastic scattering and photopion production on nucleons. The electric and longitudinal multipole moments E_{0+} and L_{0+} are calculated at threshold in terms of the form factors of the electromagnetic and weak axial-vector currents. The experimental upper bounds on the slope of the differential cross section as a function of $|q|$, the momentum in the πN c.m. system, i.e., $(1/|q|)\ (d^3\sigma/d\Omega d\omega_{2'})$, where $\omega_{2'}$ is the laboratory energy of the final electron, are sufficiently strong to relate the form factors for various values of $-k^2$, the momentum transfer squared of the electrons. More precisely, in this way the neutron charge form factor $G_e^n(k^2)$ can be related to normalized axial-vector form factor $F_A(k^2)$. If $F_A(k^2)$ is taken to have the dipole form $F_A(k^2) = (1 + k^2/M_A^2)^{-2}$ with $M_A^2 = 1.42\ BeV^2$, which is given by arguments based on chiral $SU(2) \times SU(2)$ and consistent with recent neutrino experiments, then the resulting values of $G_e^n(k^2)$ in the range considered, $0.2 \leq k^2 \leq 0.6\ BeV^2$, are consistent with information about $G_e^n(k^2)$ from electron-deuteron and thermal-neutron-electron scattering. (auth)

50332 ASYMPTOTIC BEHAVIOR OF AMPLITUDES FOR MESON PHOTOPRODUCTION. Dosch, H. G. (Massachusetts Inst. of Tech., Cambridge). Contract AT(30-1)-2098. Phys. Rev., 173: 1595-8(Sept. 25, 1968).

The asymptotic behavior of amplitudes for meson photoproduction off fermions is investigated in a simple perturbative model. It is found that a fixed power behavior and hence a fixed J-plane pole may occur even if the produced meson is "composite." The implications of this result are discussed. (auth)

50333 TWO-POLE MODEL FOR THE $\eta_{3\pi}$ DECAYS. Yun, Suk Koo (Syracuse Univ., N. Y.). Phys. Rev., 173: 1764-7 (Sept. 25, 1968).

$\eta \rightarrow 3\pi$ decays are described by a model in which the amplitudes are assumed to be dominated by two meson poles. The model is characterized by scalar, vector, and axial-vector meson poles. The strong-coupling constants in the model are obtained from the experimental decay widths. Adopting the tadpole model, the effective electromagnetic coupling is given in terms of the electromagnetic mass difference of kaons. If the D-E mixing and η-η' mixing are included, then the branching ratio, the slope, and the decay rate for the $\eta \rightarrow 3\pi^0$ are found to be in good agreement with experiment. (auth)

50334 CURRENT COMMUTATORS AND ELECTROMAGNETIC MASS DIFFERENCES. Cornwall, John M.; Norton, Richard E. (Univ. of California, Los Angeles). Phys. Rev., 173: 1637-44(Sept. 25, 1968).

A version of the Jost–Lehmann–Dyson representation is used to study the forward-spin-averaged "Compton" amplitude constructed from conserved currents. Bjorken's relationship between the divergence in electromagnetic mass shifts and the equal-time commutator of a current density and a time derivative of a current density is clarified and extended to include the case where subtractions in the amplitude are necessary. The connection between equal-time commutators and some features of the radiative corrections to β decay are discussed, and some properties of Schwinger terms are developed. (auth)

50335 ANOMALOUS NUCLEAR PHOTOPRODUCTION OF ϕ MESONS. Trefil, J. S. (Massachusetts Inst. of Tech., Cambridge). Contract AT(30-1)-2098. Phys. Rev., 173: 1629-36 (Sept. 25, 1968).

Modifications of the vector-dominance model are proposed in order to explain the anomalous size of the ϕ photoproduction cross section. It is argued that an unambiguous test of the vector-dominance model can be made by looking at the energy dependence of this cross section. An estimate of the cross section is given for the region of incident photon momenta of 9–16 GeV/c, based on nuclear photoproduction of K^- mesons. It is found that the cross section for the production of ϕ^0 mesons on protons does not increase with energy. Consequences of this conclusion for the quark model and other models of scattering are discussed. (auth)

50336 PHOTOPRODUCTION OF π- AND K-MESONS ON NUCLEONS, AND THE QUARK MODEL OF ELEMENTARY PARTICLES. Rekalo, M. P. (Inst. of Physics, Kiev). Ukr. Fiz. Zh., 12: 1576-8(1967). (In Russian).

The results of a quark model of interaction of elementary particles for the photoproduction of π and K-mesons are examined. Since the gamma quantum can virtually convert to a combination of vector mesons, the quark structure of the gamma quantum has a definite form. On assuming the additivity of quark amplitudes, an expression is obtained for the photoproduction of π-mesons on nucleons. Photoproduction of strange particles in the quark model is determined by two amplitudes. An expression is given for the amplitudes of photoproduction on a proton. This expression predicts that the cross sections of the processes $\gamma + p \rightarrow \Lambda + K^+$ and $\gamma + p \rightarrow \Sigma^0 + K^+$ should depend on the square of the transmitted momentum. It is found that the annihilation quark amplitude can be neglected in the photoproduction of strange particles. Thus, all possible processes of the photoproduction of K-mesons can be described by a single quark amplitude. A series of relations between cross sections, which can be verified experimentally, can be obtained by this means. (TTT)

50337 FIELD-CURRENT IDENTITIES AND NUCLEON RADII. Beg, M. A. B. (Rockefeller Univ., New York); Bernstein, J.; Tausner, M. Phys. Rev., 173: 1523-6(Sept. 25, 1968).

The results are presented of a calculation of the electromagnetic radii of nucleons predicated on the assumption of vector dominance for the hadronic electromagnetic current. Vector dominance is implemented through the use of field-current identities. A new feature of this work is an attempt, for the isovector radii, to take account of the structure of the ρ-nucleon vertex. While the numerical results are somewhat model-dependent, they do lend support to the view that the radii are determined by the low-energy dynamics of the meson-nucleon system. (auth)

50338 INELASTIC ELECTRON SCATTERING IN THE SYMMETRIC QUARK MODEL. II. COULOMB POTENTIAL. Thornber, N. S. (Stanford Univ., Calif.). Phys. Rev., 173: 1414-19 (Sept. 25, 1968).

The nonrelativistic quark model with a 1/r binding potential is used to compute form factors for the process $e + p \rightarrow e + N^*$, where N^* is one of ten nucleon resonances. The elastic and N^* (1236) predictions agree with experiment, but the predictions for higher excited states are too small. The features of the calculation which should hold true in any quark model and which depend on the binding potential used are discussed. (auth)

50339 ANOMALOUS MAGNETIC MOMENT OF THE A_1. Mathur, V. S.; Mohapatra, R. N. (Univ. of Rochester, N. Y.). Phys. Rev., 173: 1668-70(Sept. 25, 1968).

The Bjorken behavior of a suitable scattering amplitude is analyzed. Using a double-dispersion representation, a sum rule is obtained in the truncation approximation. The assumption that the sum rule is saturated by low-lying single-particle states leads to an evaluation of the anomalous magnetic moment of A_1. (auth)

50340 INVARIANT AMPLITUDES FOR PHOTON PROCESSES. Bardeen, W. A.; Tung, Wu-Ki (State Univ. of New York, Stony Brook). Phys. Rev., 173: 1423-33(Sept. 25, 1968).

A method for constructing independent invariant amplitudes for photon processes which satisfy gauge invariance and are free from both kinematic singularities and zeros (constraints) is proposed. The method is based on the use of a simple projection operator which automatically ensures gauge invariance at every stage. The invariant amplitudes for pion photoproduction, pion Compton scattering, and nucleon Compton scattering are found. Previously known results in the first two cases are reproduced and their interpretation is clarified. For nucleon Compton scattering the result is new. Comparisons are made between these invariant amplitudes, the Hearn and Leader amplitudes, and the regularized helicity amplitudes. The Mandelstam representation may be applied to these kinematic-singularity-free and zero-free amplitudes without any ad hoc substractions. All known low-energy theorems on photon processes can be derived most directly from these invariant amplitudes. (auth)

50341 A MEASUREMENT OF THE K_1^0–K_2^0 MASS DIFFERENCE. Carnegie, Robert Kenneth. Princeton, N. J., Princeton Univ., 1968. 92p.

Thesis.

A new measurement of the magnitude of the $K_1^0 - K_2^0$ mass difference has been completed using the "gap method." The virtue of this method, which consists of monitoring the coherently regenerated K_1^0 intensity behind two slabs of material separated by a variable air gap, is its relative freedom from possible systematic errors. The result for the mass difference does not depend on precise knowledge of either the nuclear generation amplitude or the details of the detection efficiency of the apparatus. The $K_1^0 - K_2^0$ mass difference was found to be $|m_1 - m_2| = (0.445 \pm 0.038)\ \hbar/\tau_1$ using $\tau_1 = 0.857 \times 10^{-10}$ sec for the K_1^0 lifetime. (Disser. Abstr.)

Weak

Refer also to abstract 50373.

50342 (UCRL–18399) EXPERIMENTAL EVIDENCE AGAINST THE ANGULAR MOMENTUM NONCONSERVATION SCHEME FOR

WEAK INTERACTIONS. Chen, M. (California Univ., Berkeley. Lawrence Radiation Lab.). Aug. 1968. Contract W-7405-eng-48. 4p. Dep. CFSTI.

An experiment by Friedell (MIT-2098-389) is cited which yields indirect evidence against angular momentum nonconservation in weak interactions. (J.W.R.)

50343 WEINBERG SUM RULES AND THE RATIO F_K/F_π. Srivastava, Prem P. (Centro Brasileiro de Pesquisas Fisicas, Rio de Janeiro). Notas Fis., Cent. Brasil. Pesqui. Fis., 13: 269-74(1968).

The ratio F_K/F_π is derived using Weinberg's first spectral function sum rule in SU(3) × SU(3) while the second sum rule is used only in SU(2) × SU(2). (auth)

50344 LEPTONIC DECAYS OF ELEMENTARY PARTICLES. Willis, W.; Thompson, J. (Yale Univ., New Haven). pp 295-475 of Advances in Particle Physics. Vol. I. Cool, R. L. (ed). New York, John Wiley and Sons, Inc., 1968.

A comprehensive review is given of the present status of the knowledge of the structure and charge dependence of elementary particles. A brief survey based on the most pertinent experiments is provided in Section II. The experimental evidence on the detailed structure of the leptonic interactions is presented in Section III. The last section deals with the charge dependence of the interactions. Approximately 260 references are given in chronological order, from 1934 to 1968. (L.B.S.)

50345 HIGH ENERGY MUON SCATTERING. Lederman, Leon M. (Columbia Univ., New York); Tannenbaum, Michael J. pp 1-70 of Advances in Particle Physics. Vol. I. Cool, R. L. (ed). New York, John Wiley and Sons, Inc., 1968.

An attempt is made to collect and review the subject of high-energy muon scattering in terms of results, facilities, and potential uses of high-energy muons. The following topics are discussed: cosmic ray muon experiments; muon facilities; elastic muon-proton scattering; and inelastic muon processes. 84 references. (L.B.S.)

50346 FROM THE NEUTRINO HYPOTHESIS TO FIRST EXPERIMENTS. (THE PREHISTORY OF THE NEUTRINO). Kuchowicz, B. (Univ. of Warsaw). Wszechswiat, No. 2, 33-6(1967). (In Polish).

The historical approach to the neutrino problem is outlined, from the first difficulties with energy and momentum nonconservation which were apparently observed by the physicists in beta decay in the twenties. In 1930 the great Swiss theoretician W. Pauli proposed to introduce in the decay process a neutral, hardly observable particle, which was later named the neutrino. Some years later E. Fermi proposed a quantitative theory of the beta decay which explained experimental features. The neutrino remained unobservable in practice, due to its extremely small interaction cross section, and until very recently all neutrino experiments failed. The first successful neutrino capture experiment was performed with reactor antineutrinos by Cowan and Reines in Los Alamos in the fifties; their experimental arrangement is described and results of the measurements are given. Also the recently recognized properties of the neutrino (its handedness, especially), and theoretical possibilities of a detection of its interaction with matter are reviewed. (auth) (NSA of Poland)

50347 FINITENESS OF RADIATIVE CORRECTIONS IN ALL ORDERS TO μ-DECAY. Van Nieuwenhuizen, P. (Instituut voor Theoretische Fysica, Utrecht). Nucl. Phys., B7: 160-6(1968).

The well-known result that second order radiative corrections to μ-decay are finite is generalized to all orders. (auth)

50348 ON THE HIGH-ENERGY BEHAVIOR OF THE DIFFERENTIAL CROSS SECTION OF CERTAIN INELASTIC PROCESSES INVOLVING LEPTONS. Baluni, Varoujan. (Joint Inst. for Nuclear Research, Dubna, USSR). Nucl. Phys., B7: 167-73(1968).

The analyticity of the differential cross section of certain electromagnetic and weak inelastic processes in the momentum transfer is proved in a fairly large domain. Some bounds on the behavior of the differential cross section are derived. (auth)

50349 FORM FACTOR RATIO ξ FROM A MEASUREMENT OF $K^+_{\mu 3} : K^+_{e3}$ BRANCHING RATIO. Botterill, D. R.; Brown, R. M.; Clegg, A. B.; (and others) (Nuclear Physics Lab., Oxford). Phys. Rev. Lett., 21: 766-9(Sept. 9, 1968).

By measuring the branching ratio of $K^+_{\mu 3}$ relative to K^+_{e3} a value of $\xi(0) = f_-(0)/f_+(0) = -0.08 \pm 0.15$ was obtained. This is in good agreement with the Callan–Treiman relation. (auth)

50350 NONLEPTONIC HYPERON DECAYS AND EQUAL-TIME COMMUTATION RELATIONS. COMMENT ON KUMAR-PATI THEORY. Hirano, Masanobu; Fujii, Kanji; Terazawa, Osamu (Hokkaido Univ., Sapporo). Progr. Theor. Phys. (Kyoto), 40: 114-23(July 1968).

Results derived from the prescription, introduced by Kumar and Pati to evaluate amplitudes of nonleptonic hyperon decays, are re-examined. Contrary to the conclusion of Kumar and Pati, in the case $H_{weak} = J^+_\alpha J_\alpha$ with $|\Delta I| = 1/2$ a rather poor agreement of the prediction is found with the experimental data on the S- and P-wave hyperon-decay amplitudes. Assuming $H_{weak} = g_s \cdot S^{(6)} + g_p \cdot P^{(7)}$ and $g_s/g_p = -(1.3 \sim 1.6)$ in the fundamental triplet model with $S^{(6)} \equiv \bar{\psi}\lambda_4 t$ and $P^{(7)} \equiv i\bar{\psi}\lambda_7\gamma_5 t$, a fairly good agreement of the prediction with experiment is obtained except for $S(\Sigma^\pm)$. In this case, F/D-ratios of the strong meson-baryon interaction (ξ) and of the effective bilinear parity-conserving coupling among baryons (ξ^c_w) are respectively $(0.61 \sim 0.66)$ and $-(1.1 \sim 0.8)$, where the F/D-ratio of the parity-violating bilinear coupling is assumed to be nearly equal to ξ; large values of $S(\Sigma^\pm)$ are obtained, because of the very large adjusted magnitude of the parity-violating spurion as compared with the value adopted by Kumar and Pati. (auth)

50351 STRUCTURE-DEPENDENT AXIAL-VECTOR FORM FACTOR IN CHARGED-PION RADIATIVE DECAY. Vaishya, J. S. (National Physical Lab., New Delhi. Univ. of Delhi). Phys. Rev., 173: 1757-9(Sept. 25, 1968).

The structure-dependent axial-vector form factor of charged-pion radiative decay, $\pi^+ \to l^+ + \nu + \gamma$, recently investigated by Das, Mathur, and Okubo in the soft-pion limit ($q_\gamma \to 0$), was re-examined in the framework of the "hard pion" calculation due to Schnitzer and Weinberg. The result of the present calculation is compared with that of the previous authors and also with the presently available data. (auth)

50352 MODELS OF WEAK INTERACTIONS MEDIATED BY VECTOR BOSONS. Segre, G. (Univ. of Pennsylvania, Philadelphia). Phys. Rev., 173: 1730-3(Sept. 25, 1968).

A series of models of weak interactions, involving at least six intermediate vector bosons, are displayed. They are similar to schizon models, but have the new feature of not involving the Cabibbo angle in the coupling of the hadron currents to the intermediate vector mesons. Some speculations on how weak mass shifts may cancel electromagnetic mass shifts are also presented within the framework of the model. (auth)

50353 RATIO OF AXIAL-VECTOR TO VECTOR CONTRIBUTIONS IN $K \to l\nu\gamma$ DECAY. Sarker, A. Q. (Univ. of Islamabad, Rawalpindi, Pakistan). Phys. Rev., 173: 1749-51(Sept. 25, 1968).

Sum rules are obtained by using the dispersion technique of Fubini in the radiative weak decay $K \to l\nu\gamma$. The relevant ratio of the axial-vector to vector contributions is then predicted by saturating these sum rules with a few low-lying resonance states, and its relationship with the question of subtraction in the dispersion relation of certain amplitudes in $K \to l\nu\gamma$ is also discussed. (auth)

50354 K_{l3} FORM FACTORS IN CURRENT ALGEBRA WITH HARD PION AND KAON. Riazuddin; Sarker, A. Q. (Univ. of Islamabad, Rawalpindi, Pakistan). Phys. Rev., 173: 1752-6 (Sept. 25, 1968).

The K_{l3} form factors $f_+(q^2)$ are calculated using the current commutators, partially conserved axial-vector current, the Weinberg-type sum rules, and the Schnitzer-Weinberg technique with hard pions and kaons, which involves the domination of certain vertex functions by vector and axial-vector mesons. The results are very similar to those obtained recently by B. W. Lee using chiral dynamics and field-current identity. (auth)

50355 POSSIBLE WEAK INTERACTION OF PHOTONS AND EMISSION OF NEUTRINOS FROM STARS. Bandyopadhyay, Pratul (Indian Statistical Inst., Calcutta). Phys. Rev., 173: 1481-4(Sept. 25, 1968).

It was proposed in an earlier paper that photons can interact weakly with neutrinos. The astrophysical implications of this interaction are here investigated. The energy loss rates for the pair-annihilation process $e^- + e^+ \to \nu + \bar{\nu}$ and the photon-photon process $\gamma + \gamma \to \nu + \bar{\nu}$ are obtained, using this weak-interaction property of photons. The neutrino luminosity due to the pair-annihilation process is estimated according to the present theory and is compared with that calculated on the basis of the current-current coupling theory. Some theoretical aspects of the assumed photon-neutrino weak coupling are also discussed. (auth)

50356 RELATIVISTIC CORRECTIONS TO THE RECOIL SPECTRUM IN NEUTRON β DECAY. Nachtmann, Otto (Univ., Vienna). Z. Phys., 215: 505-14(1968).

Relativistic corrections to the recoil spectrum and some correlation functions in neutron β decay are determined. Special care is taken to properly include Coulomb effects. (auth)

Strong (General)

Refer also to abstract 50374.

50357 (CERN-68-31) TOPICS ON REGGE-POLE THEORY OF HIGH-ENERGY SCATTERING. Van Hove, L. (European Organization for Nuclear Research, Geneva (Switzerland)). July 25, 1968. 79p. Dep.

A series of lectures describe the basic features of Regge-pole theory for high-energy hadron scattering processes and some of the more recent problems occurring when experimental data are analyzed in terms of this model. (J.W.R.)

50358 WIDTH OF HADRONS. Matthiae, G. (Istituto Superiore di Sanita, Rome). Nucl. Phys., B7: 142-6(1968).

A calculation of the average value of the width of hadrons as a function of the mass is reported. The approach, which makes use of the mass spectrum of hadrons as predicted by the thermodynamical model, is based on the application of the principle of detailed balance. (auth)

50359 WILL THE RESONANCES ON THE LEADING TRAJECTORIES BECOME STABLE TO STRONG DECAY AT HIGH SPIN? Goldberg, Hyman (Northeastern Univ., Boston) Phys. Rev. Lett., 21: 778-81(Sept. 9, 1968).

A heuristic discussion is given of the decay modes of high-spin particles lying on a linearly rising trajectory. Among other things, it is concluded that for particles with masses $\gtrsim$3500 MeV ($J \gtrsim 12$), the total decay widths decrease with J and go to zero approximately like $(J \ln J)^{-0.28J}$ as $J \to \infty$ ($0.28 = 2m_\pi b^2$, where $b \simeq 1\ \mathrm{GeV}^{-2}$ is asymptotic slope of the rising trajectory). (auth)

50360 STRANGE SPIN FORMALISM FOR HADRONS. Shima, Kazuhisa; Suzuki, Tsuneo; Kobayashi, Akizo; Senju, Hirofumi (Nagoya Univ., Japan). Progr. Theor. Phys. (Kyoto), 40: 143-59 (July 1968).

A model in which a new kind of spin, namely "strange spin X ($X_3 = \frac{1}{2}S$)," plays an important role besides isotopic spin I is set up on the basis of four constituent baryons with integral electric charges and integral baryon numbers. These basic baryons form two doublets such as ($I = \frac{1}{2}$, $X = 0$) and ($I = 0$, $X = \frac{1}{2}$). The mass formula characteristic of the model, based on the broken U(4)-symmetry, accounts for the mass spectra of a super-multiplet involving new baryons such as $Z_0(1863)$, $Z_1(1910)$, and aleph-particle ($m = 2040 \pm 50$) in addition to the usual octuplet ones. Also the formula brings the Gell-Mann-Okubo mass relation to the usual octuplet baryons and the Bjørken-Glashow one to the usual nonuplet mesons. The selection rules based on the U(4)-symmetry account roughly for the low rate of the X^0-production in the π-N reaction, and are compatible with the branching ratios of the strong decay mode of φ and with the suppression of the φ-production in the N-N and π-N reactions in comparison with the ω-production. Application of the present formalism to the electromagnetic interaction is also referred to. (auth)

50361 SOLUTION OF THE BETHE–SALPETER EQUATION FOR FERMIONS. Byckling, Eero; Kallio, Alpo (Univ. of Oulu, Finland). Ann. Acad. Sci. Fenn., Ser. A VI, No. 276, 1-18(1968).

A method of solving the Bethe–Salpeter equation accurately is given in the case of an instantaneous interaction and unequal masses of two spin-$\frac{1}{2}$ particles. Explicit sets of coupled integral equations are derived for the wave functions of the $^1S_0$, $^3S_1$ and $^3P_0$ states, which one may solve by suitable numerical methods. (auth)

50362 DIFFRACTION SCATTERING AND VECTOR-MESON RESONANCES. Atkinson, D. (Univ. of California, Berkeley); Contogouris, A. P. J. Math. Phys. (N. Y.), 9: 1489-1500(Sept. 1968).

It is shown that, under reasonable assumptions about inelasticity and asymptotic behavior, the usual diffraction picture combined with the N/D approach to π-π scattering leads to a singular integral equation. The formalism is then used to show that, in conformity with the nearby-singularities philosophy, a constant left-hand discontinuity is by itself incapable of producing resonances in the GeV region. Next, a model for the creation of vector resonances, which combines a long-range force (defined by exchange of a cutoff vector meson) plus a short-range force (compatible with diffraction requirements), is introduced. The effect of the short-range force on the self-consistent (bootstrap) solutions is investigated in an approximate scheme. For a self-consistent solution with the correct ρ-meson mass, which is found to exist, inclusion of the short-range force is shown to decrease the self-consistent width by a factor of 2, which is nevertheless still greater than the experimental value. (auth)

50363 WATSON'S THEOREM WHEN THERE ARE THREE STRONGLY INTERACTING PARTICLES IN THE FINAL STATE. Aitchison, I. J. R. (Oxford Univ.); Kacser, C. Phys. Rev., 173: 1700-8(Sept. 25, 1968).

Amado has recently conjectured the following extension of Watson's final-state-interaction theorem: The phase of an amplitude leading to a final state with three strongly interacting particles, when considered as a function of the relative energy of one pair, in a given-pair partial wave, all other variables being held constant, is the scattering phase of that pair, δ. This conjecture is investigated in two simple, complementary models. In the first, a final-state interaction is grafted on to a specific production amplitude; as expected, if the production amplitude is real, the phase of the total amplitude is δ. The question of the phase turns out to be intimately related to the question of whether triangle singularities are observable or not; Amado's results on this point are corrected. In the second model, the production mechanism is ignored and attention is focused on the possibility that there may be two ("overlapping") resonances in the final state. Here the theorem does not hold, in general (however it does turn out that the corrections are either small or easily calculable). In this case too, the phase question is linked with the observability of triangle singularities, and the rather negative conclusions reached by Schmid (who also treated this second model) are criticized. A basic tool is a theorem that the on- and off-shell parts of a rescattering graph contribute equally near a singularity which is near the physical region. (auth)

50364 ANALYTIC CONTINUATION OF DIVERGENT INTEGRALS WITH RESPECT TO A PARAMETER: THE CASE OF PERTURBATIONS TO STRONG INTERACTIONS. Suzuki, Mahiko (Inst. for Advanced Study, Princeton, N. J.). Phys. Rev., 173: 1473-80(Sept. 25, 1968).

A principle is proposed to overcome divergent integrals in various formulas by continuing them analytically with respect to an appropriately chosen parameter. The analyticity is examined on the complex plane of the parameter in the case of the formula for the electromagnetic mass difference, as an example. The contributions from the Regge terms including the Regge cuts are discussed in detail, specifically in connection with the tadpole model. (auth)

50365 ASYMPTOTIC BEHAVIOR OF FORM FACTORS FOR SOME COMPOSITE MODELS. Ciafaloni, M.; Menotti, P. (Scuola Normale Superiore, Pisa, Italy. Istituto Nazionale di Fisica Nucleare, Pisa, Italy). Phys. Rev., 173: 1575-83 (Sept. 25, 1968).

The asymptotic behavior of electromagnetic form factors is examined for bound states treated by means of the Bethe-Salpeter equation in the ladder approximation. Results are found which depend on the behavior of the interaction at small distances, and the models examined are accordingly divided into regular and singular cases. For spin-0 and spin-$\frac{1}{2}$ bound states with regular interaction, the form factors go to zero as $(1/q^2)^2$ (apart from logarithmic factors). For singular cases (e.g., a spinless N-$\bar{N}$ bound state) it is shown that the asymptotic behavior is worse and depends on the strength of the interaction. In all cases a behavior more convergent than $1/q^2$ seems to occur, and to be related to the compositeness of the system rather than to the structure of the interaction. (auth)

50366 MULTIPLE SCATTERING IN THE QUARK MODEL. Harrington, David R.; Pagnamenta, Antonio (State Univ. of New Brunswick, N. J.). Phys. Rev., 173: 1599-1607(Sept. 25, 1968).

It is shown that a systematic analysis of multiple-scattering contributions in the quark model can explain the detailed structure of the hadronic differential cross sections at high energies. As an extension of previous work on multiple-scattering effects in the quark model, the high-energy differential cross sections are fitted for nucleon-nucleon, nucleon-antinucleon, and pion-nucleon scattering, assuming simple forms for the quark-quark scattering amplitudes and the baryon and meson form factors. Of the ten parameters involved, seven are determined by measurements at forward or near-forward angles, leaving the entire wide-angle cross sections to be fitted by the remaining three parameters. Reasonably good fits are obtained to the present data, and calculations at higher t values which may become experimentally accessible in the near future are presented. The parameters found provide some information about the interactions of quarks (should they exist) at high energy and are used to calculate double-scattering corrections to total cross sections and the phase of the nucleon-nucleon amplitude as a function of momentum transfer. (auth)

50367 STRONGLY DECAYING PARTICLES AND RELATIVISTIC INVARIANCE. Lurcat, Francois (Inst. for Advanced Study, Princeton, N. J.). Phys. Rev., 173: 1461-73(Sept. 25, 1968). (NP-17385).

Before the discovery of strongly decaying particles ("resonances"), it was a good approximation to consider that all elementary particles are elementary systems, i.e., that their states transform according to an irreducible representation of the Poincaré group. This approximation is not valid for the strongly

decaying particles, because they have a mass spectrum which cannot be neglected. To treat these particles on the same footing as the stable (or metastable) ones, one has to give a new definition of an elementary system. The consequences of this definition for the one-particle states are described. The representation is no longer irreducible, but is multiplicity-free. The mass is a superselection rule; the states are described by density matrices, or better, by characteristic functions, defined on the Poincaré group. Specific examples are discussed (ρ and ω mesons); the relevance of the new concepts introduced here for the quantum field theory of strong interactions is mentioned. (auth)

Strong (Baryon No. = 0)

Refer also to abstracts 50321 and 50409.

50368 (JINR-P2-4035) POSSIBILITY OF ABNORMALLY LARGE WIDTH OF E(1420) → 2γ DECAY. Zaslavskii, A. N.; Tybor, B. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab of Theoretical Physics). 1968. 11p. (In Russian). Dep.

Evaluations were made of the width of the decay E → 2γ within the limits of disturbed symmetry $SU(6)_W$. The magnitude of the width strongly depends on the scheme of disturbance of $SU(6)_W$. An abnormally large width of ≈1 MeV was found to be quite feasible. (tr-auth)

50369 (UR-875-253) R-REGION AND OTHER MULTIPION RESONANCES. Ferbel, T. (Rochester Univ., N. Y. Dept. of Physics and Astronomy). Aug. 1, 1968. Contract AT(30-1)-875. 55p. (CONF-680428-11). Dep. CFSTI.

From Conference on Experimental Meson Spectroscopy, Philadelphia, Pa.

Some new information regarding the f^0, B-meson, and the resonances in the R-region is discussed. A few brief remarks are also given concerning the A_1. (L.B.S.)

50370 NEW CLASS OF SUPERCONVERGENT SUM RULES FOR SCATTERING AMPLITUDES. Narayan, D. S. (Tata Inst. of Fundamental Research, Bombay); Saxena, R. P.; Srivastava, Prem, P. Notas Fis., Cent. Brasil. Pesqui. Fis., 13: 307-13 (1968).

A class of superconvergent sum rules was recently proposed by postulating that the difference of two suitable invariant amplitudes, one representing the scattering of a vector particle against some target and the other representing the scattering of the corresponding axial vector particle against the same target, satisfies a superconvergent dispersion relation. The sum rules which can be obtained by considering the scattering of ω and ϕ on pions are examined. Sum rules for the interactions $\rho_0 + K^+ \to \rho_0 + K^+$ and $A_1^0 + K^+ \to A_1^0 + K^+$ are also considered. (L.B.S.)

50371 ON THE BOUND STATES OF THE RELATIVISTIC TWO-PARTICLE HAMILTONIAN. Atanassov, A. A. (Higher Pedagogical Institu, Plovdiv, Bulgaria). Compt. Rend. Acad. Bulg. Sci., 21: 315-18(1968).

Problems pertaining to the bound states of two particles described by a relativistic two-particle Hamiltonian are considered. An attempt is made to find the upper limit of the number of these states and to find the algorithm on the approximate determination of bound states without knowing the solutions of the equation. The results may be used in the quark model when mesons are examined as bound states of quarks and antiquarks. (C.E.S.)

50372 PION CONSPIRATOR: A FURTHER EVIDENCE FOR ITS EXISTENCE AND A DISCUSSION ON ITS IMPLICATIONS IN MESON SPECTROSCOPY. Di Vecchia, P. (CNEN, Frascati, Italy); Drago, F.; Ferro Fontan, C.; Odorico, R. Phys. Lett., 27B: 521-4(Sept. 16, 1968).

New evidence is presented for a Regge pole pion conspirator π_c. A Regge pole with the same trajectory previously determined for π_c from conspiring amplitude $F_3^{(-)}$ was found by applying continuous moment sum rules to the analysis of $F_1^{(-)}$. Regge parameters of the A_2 were also found, which provided some evidence for A_2 choosing the Chew mechanism at $\alpha = 0$. The connection between the existence of the π_c and the doublet structure of the A_2 resonance is discussed, and some arguments are given to classify the A_1 resonance as a recurrence of the first pion daughter. The possibility of considering the A_3 as a further recurrence of this trajectory is also discussed. (L.B.S.)

50373 MESON-DECAY PROCESSES AND THE RELATIVISTIC QUARK MODEL. Kitazoe, T.; Teshima, T. (Kobe Univ., Japan). Nuovo Cim., 57A: 497-522(Oct. 1, 1968).

The meson interaction in the relativistic quark model is formulated by the combined use of the graphical method of Mandelstam and the reduction formula of Nishijima and Zimmermann in the boundstate problem. The matrix element of the interaction then is expressible in terms of the Bethe-Salpeter amplitudes describing bound quarks and a function M given by an irreducible graph. It is found that the matrix element of a certain process is determined only by the effective coupling constants of some other processes and the masses of mesons, without any knowledge of the masses of quarks and the potential between quarks. This fact, on the one hand, predicts the same results as the so-called vector-meson dominance model does about the electromagnetic form factor of a meson and the decay processes such as $\pi^0 \to 2\gamma$, $\eta \to 2\gamma$, $\omega \to \pi\gamma$, $K \to \pi l\nu$, etc. and, on the other, it implies the Goldberger-Treiman relation, when it is applied to the β-decay of the nucleon. A certain approximation is made for the B-S amplitudes and the function M, which enables the calculation of the effective coupling constants, so that every matrix element may be represented by only three parameters, g_ρ, c_τ and $g_{\rho\pi\pi}$. The matrix elements thus obtained reflect the SU_3 symmetry with a small breaking. Numerical results for the decay rates of mesons are in good agreement with experiment. In addition, it is shown in the processes $\omega \to e^+e^-$, $\pi^0 \to 2\gamma$ and $\eta \to 2\gamma$ that the nonintegral charges usually assumed for the quarks are exceedingly more favorable than the integral charges. (auth)

50374 STRONG-COUPLING CONSTANTS AND DECAYS OF HADRONS IN A RELATIVISTIC QUARK MODEL. Boehm, M. (Univ., Wuerzburg, Ger.); Gudehus, T. Nuovo Cim., 57A: 578-87(Oct. 1, 1968).

Relations between strong-coupling constants of hadrons and hadron resonances are calculated in the framework of a relativistic quark model. Using these relations, the decay widths of the $\frac{3}{2}^+$-baryon resonances and the 2^{++}-meson resonances are calculated. (L.B.S.)

50375 PRODUCTION OF AN ADDITIONAL MESON IN HADRON SCATTERING AND A QUARK MODEL FOR INTERACTIONS OF ELEMENTARY PARTICLES. Rekalo, M. P. (Inst. of Physics and Tech., Kharkov). Ukr. Fiz. Zh., 13: 1198-1204(July 1968). (In Russian).

By using a quark model of elementary particle interactions the production of an additional meson in the processes $\bar{p} + p \to \bar{B} + B + M$ and $K^- + p \to B + M_1 + M_2$ is discussed. The model predicts a large number of relations between cross sections and suppression of some production processes. (auth)

50376 COMPARISON OF THE DIP-BUMP STRUCTURE IN $\bar{p}p$ AND $\bar{p}n$ ELASTIC SCATTERING. Berryhill, J.; Cline, D. (Univ. of Wisconsin, Madison). Contract AT(11-1)-881. Phys. Rev. Lett., 21: 770-1(Sept. 9, 1968). (COO-881-189).

$\bar{p}n$ and $\bar{p}p$ elastic scattering were studied in the momentum-transfer region of $t = -0.15$ to $t = -1.0$ $(BeV/c)^2$ using the reaction $\bar{p}d \to \bar{p}np_s$ or $\bar{p}pn_s$, where p_s and n_s are spectators. The $\bar{p}n$ elastic cross section shows a dip at $t \sim -0.4$ similar to that seen in the $\bar{p}p$ cross section. A comparison of the $\bar{p}n$ and $\bar{p}p$ cross sections shows that they appear to cross over each other, $t \sim -0.4$ $(BeV/c)^2$. (auth)

50377 CURRENT ALGEBRA AND THE PION TRAJECTORY. Sawyer, R. F. (Univ. of California, Santa Barbara). Phys. Rev. Lett., 21: 764-6(Sept. 9, 1968).

It is shown that one conventional interpretation of the success of current-algebra results requires the pion Regge trajectory to choose the Toller quantum number M = 0 at zero energy. (auth)

50378 SATURATION OF SUPERCONVERGENCE RELATIONS FOR PSEUDOSCALAR PSEUDOSCALAR SCATTERING. Miyamura, Osamu; Takagi, Fujio (Tohoku Univ., Sendai). Progr. Theor. Phys. (Kyoto), 40: 179-81(July 1968).

The saturation of the superconvergence relations for forward pseudoscalar-meson octet (P_8)–pseudoscalar-meson octet scattering by a number of one-particle states is investigated in the framework of the exact SU(3) symmetry. (L.B.S.)

50379 MESON STRUCTURE AND SPIN-ORBIT SPLITTING OF MESON MASS. Otsuki, Shoichiro (Kyushu Univ., Fukuoka). Progr. Theor. Phys. (Kyoto), 40: 190-2(July 1968).

It has been pointed out that the mass of those mesons that can be kinematically interpreted as a bound quark pair with the internal orbital angular momentum L = 1 is characterized by a positive spin-orbit (LS) splitting of about 100 MeV. It is noted that the LS splitting is of the order usually encountered in hadron interactions such as nuclear forces. An estimate is given on the basis of the cluster model of hadrons, to show that the LS mass splitting is consistent with the LS part of nuclear forces if the meson structure is characterized by an appreciable configuration of baryon-antibaryon pair. (L.B.S.)

50380 CLUSTER MODEL OF HADRONS. II. MASS SPECTRUM AND DECAY OF MESONS. Otsuki, Shoichiro (Kyushu Univ., Fukuoka); Sawada, Shoji; Toyoda, Fumihiko. Progr. Theor. Phys. (Kyoto), 40: 128-42(July 1968).

Mass spectrum and decay of mesons are examined under the

assumption that the meson structure is described by configuration of the ground state baryon pair and that of two mesons of the pseudoscalar and/or vector type. The mass spectrum is explained if the dominant configuration is of the $|M_8^8\rangle \sim |B_8^7\rangle|\bar{B}_8^8\rangle$ type, not of the $|B_7^8\rangle|\bar{B}_7^8\rangle$ type nor the two-meson configuration. On the other hand the two-meson configuration is important in decay processes and satisfactorily reproduces experiment. It is discussed that these two configurations enable us to define inside mesons a quasiparticle with the same fractional quantum numbers (charge and hypercharge) as the quark. (auth)

50381 THREE-PARTICLE FINAL STATES IN THE QUARK MODEL. Das Gupta, Sutapa (Univ. of Delhi). Phys. Rev., 173: 1745-9(Sept. 25, 1968).

Scattering processes at high energies involving the production of a single meson are studied in the framework of a SU(6) × O(3) quark model which was recently proposed for high-energy hadron-hadron processes. A large number of interesting sum rules, including some weaker predictions of SU(3), are obtained for the nonresonant production cross sections of pp, π^+p, and K^+p processes. A comparison of the results with the available experimental information for these reactions indicates fair agreement for many of these predictions. (auth)

50382 GENERALIZED SUPERPERTURBATION THEORY FOR SCATTERING. Madan, Rabinder N. (Princeton Univ., N. J. Univ. of California, Santa Barbara). Phys. Rev., 173: 1615-21 (Sept. 25, 1968).

A method of solving the Schrödinger equation for scattering in an arbitrary state of angular momentum is presented by forming the solution out of a real amplitude function A and a real phase function B. A satisfies a nonlinear differential equation with the virtue that it has no nodes for "physical" potentials. B is simply related to A. With these equations a superperturbation theory for phase shifts can be formulated, being defined as a sequence of approximations in which the error at any stage is of the order of the square of the error at the previous stage. A great advantage of this scheme lies in numerical computations, where its greater speed of convergence over standard methods is demonstrated in a test case. It was found that in the case of s-wave scattering from an exponential potential the superperturbation scheme converged in three interactions, whereas the Green's-function method required 27 iterations. (auth)

50383 EQUAL-MASS CONSPIRACY RELATIONS AS THE LIMIT OF THE UNEQUAL-MASS CASE. Stack, John D. (Univ. of Illinois, Urbana). Phys. Rev., 173: 1644-50(Sept. 25, 1968).

It is proven that conspiracy relations for equal-mass scattering are always the limits of the linear relations among helicity amplitudes for the unequal-mass case. The proof is illustrated by detailed consideration of the $\pi\rho \to N\bar{N}$ reaction. (auth)

50384 CURRENT ALGEBRA, CROSSING SYMMETRY, AND UNITARITY FOR s-WAVE ππ SCATTERING. Datta, K.; Gupta, K. C.; Varma, V. S. (Univ. of Delhi). Phys. Rev., 173: 1549-51 (Sept. 25, 1968).

The s-wave pion-pion scattering lengths and phase shifts are calculated using the algebra of currents and dispersion relations. Three pions are dispersed, and in the nonsoft off-shell $q_\pi^2 \to 0$ limit for these pions the algebra of chiral SU(2) × SU(2) and the σ model are used to obtain an amplitude which is explicitly crossing-symmetric. This amplitude is used to provide the N function for the s-wave pion-pion amplitude written in the usual N/D form. The calculated scattering lengths and phase shifts depend on a parameter related to the $\sigma A_1\pi$ coupling. The results agree reasonably well with the recent experimental estimates by Walker et al. even when the $\sigma A_1\pi$ coupling vanishes. (auth)

50385 s AND t CHANNEL EFFECTS IN LOW ENERGY $\bar{N}N$ ELASTIC SCATTERING. Berryhill, J.; Cline, D.; English, J. (Univ. of Wisconsin, Madison). Contract AT(11-1)-881. Phys. Lett., 27B: 573-5(Sept. 30, 1968). (COO-881-184).

It is shown that $\bar{p}p$ and $\bar{p}n$ elastic scattering data in the laboratory momentum range 0.3 to 2.0 GeV/c show qualitatively similar features to high energy $\bar{p}p$ elastic scattering when the data are plotted as a function of t, except for scattering angles in the far backward hemisphere (in the center of mass). In particular, while the average value of the 180° cross section is given by $d\sigma/dt$ at the relevant t value, direct channel effects appear to cause the cross section to fluctuate around the $d\sigma/dt$ value. This suggests that most of the backward cross section is dominated by t channel exchanges rather than direct channel resonances even at low energies. (auth)

50386 UNITARITY CORRECTIONS TO POLE DOMINANCE IN SPECTRAL-FUNCTION SUM RULES. Lam, W. S.; Raman, K. (Brown Univ., Providence). Phys. Rev., 173: 1497-1504(Sept. 25, 1968).

Unitarity corrections to pole dominance in Weinberg's spectral-function sum rules and the corresponding sum rules for asymptotic SU_3 and $SU_3 \times SU_3$ are evaluated in a model in which we use the field-current identities for the vector and axial-vector currents, and in which the propagators of the vector, axial-vector, and pseudoscalar mesons are evaluated in a chain approximation. This gives sum rules relating the various coupling constants and masses. It is pointed out that although the unitarity corrections to the coefficients of λ_1^1, $\lambda_{1_A}^1$, etc., in the spectral-function sum rules are within 20 to 30%, they can give rise to significant deviations from the pole-dominance predictions for decay rates and mass ratios. (auth)

50387 DOUBLE BOOTSTRAP OF THE ρ AND f^0. Everett, Allen E. (Tufts Univ., Medford, Mass.). Phys. Rev., 173: 1663-7 (Sept. 25, 1968).

A "double bootstrap" of the ρ and f^0 mesons is obtained, in which the input force consists of both ρ and f^0 exchange, and both particles are obtained as output resonances, with corresponding input and output values of masses and widths being equal to within about 1%. The values obtained for the resonance parameters are m_ρ = 750 MeV, Γ_ρ = 162 MeV, m_f = 1240 MeV, and Γ_f = 100 MeV, in reasonable agreement with experiment. The ρ width is somewhat larger than most measured values, but much smaller than generally obtained in bootstrap calculations in which only ρ exchange is included as an input force. The calculations are carried out using the equivalent-potential method, and are free of arbitrary parameters. The model yields a second I = 0, j = 2 resonance, presumably to be associated with the $f^{0\prime}$ and also a broad second P-wave resonance. The latter may correspond to the ρ′ Regge trajectory hypothesized in several Regge-pole analyses of high-energy data, especially the polarization in πN charge exchange. The parameters of the predicted resonance do not agree with those of any known resonance, but it might be difficult to observe because of its width. The output Regge trajectories predicted by the model are roughly linear. The ρ trajectory has a slope about half the generally accepted experimental value of 1 BeV^{-2}. It is commented that general considerations, based only on the crossing matrix, make it somewhat difficult to reconcile the latter value with the absence of an I = 0 D-wave resonance at an energy less than 1250 MeV. (auth)

50388 POMERANCHUK THEOREM FOR PARTIAL WAVES AND NARROWING OF RESONANCE WIDTHS: THE ρ MESON. Desai, Bipin R.; Gregorich, David T. (Univ. of California, Riverside). Contract AT(11-1)-34-P107A. Phys. Rev., 173: 1434-9 (Sept. 25, 1968).

A model is proposed, within the framework of single-channel Frye-Warnock formalism, in which it is assumed that at high energies low partial waves become purely imaginary. A Pomeranchuk-type theorem then implies that the Frye-Warnock Born term must vanish asymptotically. Thus no cutoffs are needed in the integral equations. For the P-wave ππ amplitude it is assumed that only the nearby part of the left cut (i.e., the part up to a finite negative value $-s_A$) is given by the discontinuity due to elementary ρ exchange. The rest of the left cut is assumed to be given by the asymptotic right-hand discontinuity which, because of unitarity, is positive and $\leq 1/2$, and is smaller than the abnormally large discontinuity (≈3) given, in the earlier models, by the elementary ρ exchange. For the right cut of the Frye-Warnock Born term, two cases were considered: (a) The absorption parameter η(s) is assumed constant beyond $s = 100m_\pi^2$. (b) The η(s) is assumed constant ($=\eta_0$) between $100m_\pi^2$ and $300m_\pi^2$, and beyond $300m_\pi^2$ it is assumed to be ≈0.5 as given by Regge fits with a flat Pomeranchuk trajectory. Unlike earlier models, the width of the ρ can be controlled. Its value is very sensitive to η_0. For case (a) with $\eta = 0.2 \times 10^{-1}$ and $s_A = 225m_\pi^2$, and for case (b) with $\eta_0 = 0.2 \times 10^{-3}$ and $s_A = 380m_\pi^2$, we obtain m_ρ = 760 MeV and the ρ width Γ_ρ as small as 100 MeV. (auth)

Strong (Baryon No. = 1)

Refer also to abstracts 50295, 50320, 50325, and 50374.

50389 (KFKI-21/1968) π-N RESONANCE WIDTHS IN THE BROKEN SL(2,C) MODEL. Szego, K.; Toth, K. (Magyar Tudomanyos Akademia Kozponti Fizikai Kutato Intezete, Budapest). Aug. 28, 1968. 8p. Dep.

The elastic decay width of some πN resonances is evaluated in the SL(2,C) model of Regge-poles. Two families of resonances are examined in the first order of symmetry breaking, one of them has isotopic spin I = 1/2, the other I = 3/2. The width of other resonances along the trajectories is calculated in symmetry limit and the differential cross section is examined for πN backward scattering. The results are in good agreement with experiments. (auth)

50390 COLLISIONS BETWEEN POSITIVE K-MESONS AND PROTONS AT 3 GeV/c. Saellstroem, Pehr. Stockholm, Univ. of Stockholm, 1968. 11p.

Thesis

A summary is made of 3 published papers by the author on the following topics: K^+ p elastic scattering at 3.0 GeV/c; The reaction $K^+ p \rightarrow KN\pi$ in all three final charge states at 3 GeV/c; The reaction $K^+ p \rightarrow KN\pi$ at 3 GeV/c including the production and decay of resonances. (Sweden)

50391 MODEL FOR HIGH-ENERGY INELASTIC PROCESSES. Fincham, D. G.; Migneron, J. H. R.; Moriarty, K. J. M. (Imperial Coll. of Science and Tech., London). Nuovo Cim., 57A: 588-92 (Oct. 1, 1968).

The difficulties associated with the absorption model for explaining baryon-baryon and meson-baryon interactions are pointed out. The overlap matrix of Białas, Van Hove, and Zalowski (Nuovo Cimento, 38: 1385(1965), 46A: 425(1966)) is used to derive a model in which the dominant inelastic channels are related to each other explicitly, while the remaining background terms are parametrized in terms of the initial-state elastic scattering. A simplified version of this model is then applied to π- and K-nucleon charge-exchange scattering. (L.B.S.)

50392 η ASYMMETRY WITHOUT C NONCONSERVATION. Yuta, H.; Okubo, S. (Univ. of Rochester, N. Y.). Phys. Rev. Lett., 21: 781-4(Sept. 9, 1968).

The charge asymmetry for the reaction $\pi^- p \rightarrow n\pi^+\pi^-\pi^0$ is calculated assuming C invariance for the η decay. It is found that interference terms with a 3π background amplitude give a nonzero charge asymmetry. Assuming that the background in the η mass region (10 MeV) is about 10% of the η signal, a maximum asymmetry of about 2% is obtained, implying that the experimental asymmetry does not necessarily imply C nonconservation. (auth)

50393 ON THE SINGLE ρ REGGE-POLE EXCHANGE MODEL AND THE πN CHARGE-EXCHANGE PROCESS. Meng, Ta-chung; Schlaile, H. G.; Strauss, R. (Univ., Karlsruhe, Ger.). Nucl. Phys., B7: 133-41(1968).

The nonzero polarization as well as the structure in the empirical background of the forward amplitude for the πN charge-exchange process can be readily understood in the framework of the single ρ Regge-pole exchange model. (auth)

50394 USE OF FACTORIZATION IN CONSTRUCTING SUPERCONVERGENT SUM RULE. Seth, V. P.; Agarwal, B. K. (Allahabad Univ., India). Progr. Theor. Phys. (Kyoto), 40: 187-8(July 1968).

The factorization principle of Gell-Mann is used to obtain a superconvergence relation for the reactions ($\pi\Xi \rightarrow \pi\Xi$) and ($K\Xi \rightarrow K\Xi + \bar{K}\Xi \rightarrow K\Xi$). The relation is tested by taking contributions from the low lying intermediate states, and the isospin projection operators are used to obtain contributions in the t-channel. (L.B.S.)

50395 DETERMINATION OF THE COUPLING CONSTANT $g_{NN\eta'}$ Sasaki, Shosuke (Osaka Univ.). Progr. Theor. Phys. (Kyoto), 40: 188-90(July 1968).

The dispersion relation of the partial wave amplitudes for the $\pi + N \rightarrow \eta + N$ interaction was used to determine the coupling constant $g_{NN\eta'}$. The value obtained, $g^2/4\pi = 4.2$, is in agreement with experimental data. (L.B.S.)

50396 ABSORBING HARD CORE AND REGGE CUTS. Kimel, Isidoro; Miyazawa, Hironari (Univ. of Chicago). Contract AT-(11-1)-264. Progr. Theor. Phys. (Kyoto), 40: 124-7(July 1968). (COO-264-395).

A rigid absorbing core in elastic scattering requires a cut to be associated with a Regge pole. The polarization of the neutron in the $\pi^- p$ charge exchange due to the ρ-Regge pole and the cut is calculated. (auth)

50397 SEARCH FOR BARYONIC RESONANCES WITH S = +1 IN K^+p PRODUCTION EXPERIMENTS. Bassompierre, G. (CERN, Geneva); Goldschmidt-Clermont, Y.; Grant, A.; (and others). Phys. Lett., 27B: 468-73(Sept. 2, 1968).

In about 30,000 identified events produced in K^+p reactions at incident momenta 3.0, 3.5 and 5.0 GeV/c a search was made for the production of Z*'s, i.e., S = +1, T = 0 or 1 baryonic resonances. No indication was found in the examination of the various available production reactions of Z* decaying with visible modes. Upper limits for the corresponding cross sections are generally less than 30 μb at 3.0 and 3.5 GeV/c. 10 μb at 5.0 GeV/c. Summing for a given production reaction over all possible Z* decay modes, i.e., performing a missing mass type of analysis, does not reveal any further evidence. (auth)

50398 POLARIZATION IN $\pi^- p \rightarrow \eta n$, THE DOUBLE-POLE A_2, AND A POSSIBLE PION CONSPIRATOR. Austin, D. M.; Beaupre, J. V.; Lassila, K. E. (Iowa State Univ., Ames). Phys. Rev., 173: 1573-5(Sept. 25, 1968).

The $\pi^- p \rightarrow \eta n$ differential-cross-section data are analyzed within the Regge framework, using two A_2 trajectories which are constrained to reproduce the double-pole characteristics at J = 2, $t = (1.3\ \text{GeV})^2$ of the A_2 mass distribution. The best fit yields an upper trajectory degenerate with that for the ρ and a lower-lying trajectory degenerate with that for the pion at t = 0 (a possible pion conspirator). The calculated neutron polarization is in reasonable agreement with new measurements, although these data were not employed in the fitting. (auth)

50399 STUDY OF πN AND KN ELASTIC AND INELASTIC SCATTERINGS AND THEIR POLARIZATIONS BY A MULTIPLE-REGGE-POLE MODEL. Chen-Cheung, Fei S. (St. John's Univ., Jamaica, N. Y.). Phys. Rev., 173: 768-76(Sept. 25, 1968).

The presently available data on pion-nucleon scattering for incident momenta from 6 to 18 GeV/c and for small values of momentum transfer [$|t| < 1\ (\text{GeV/c})^2$] are analyzed using a model characterized by the dominance of several meson Regge poles in the crossed channels. Among the processes considered are π^+p and π^-p elastic scattering and the charge-exchange reactions $\pi^- p \rightarrow \pi^0 n$ and $\pi^- p \rightarrow \eta^0 n$. All the contributing meson trajectories, P, P', ρ, and A_2, are taken into account. The following KN reactions: K^-p, K^-n, K^+p, K^+n elastic scattering and the $K^- p \rightarrow K^0 n$ charge-exchange reaction, are also analyzed with the contributing trajectories P, P', ρ, A_2, and ω. It is found that both σ_{tot} and $d\sigma/dt$ data for pion-nucleon reactions can be very well fitted by the model with energy-independent residue functions. The polarization data are well fitted, and determine the residue functions of P, P', and ρ. These parameters are then used to fit the KN data to obtain the residue function of ω. The polarizations of the KN scatterings for which data are still lacking are predicted by the model. In connection with the speculation that the P' trajectory may behave like the ρ trajectory, three alternative trajectories are assumed for P', and their corresponding residue functions determined by the given data. The results are plotted, and it is found that the "predicted" polarizations are not very sensitive to the variation of the P' trajectory. The results show that the nonflip residue functions of both ω and ρ cross the t axis near $0 < |t| < 0.1\ (\text{GeV/c})^2$, while those of P and P' do not. The relative sign between different trajectories was established. It is also pointed out that in the fittings more constraints derived from the sum rules are verified in the present work. (auth)

50400 PARAMETERS OF LOW-ENERGY Λ-K^0 PRODUCTION. Rush, J. Edwin Jr. (Univ. of Alabama, Huntsville). Phys. Rev., 173: 1776-87(Sept. 25, 1968).

A pole-resonance model is used to fit the data for $\pi^- p \rightarrow \Lambda K^0$ from threshold to 1200 MeV. Parameters of the three pole contributions are taken from a study of the 1370 to 2200-MeV region, with form factors employed. The reduced widths of eight resonances are then determined by minimizing χ^2. The most significant contributions to the process are found to be those of the $P_{11}(1470)$ and $S_{11}(1710)$, although other resonances are also important. The results are discussed with consideration given to SU(3) assignments and parity doubling. (auth)

50401 SUM RULES FOR MESON-BARYON SCATTERING FROM ASYMPTOTIC SYMMETRY REQUIREMENTS. Seth, V. P. (Allahabad Univ., India); Agarwal, B. K.; Gupta, Y. M. Phys. Rev., 173: 1759-60(Sept. 25, 1968).

The processes $KN \rightarrow KN$ and $K\Sigma \rightarrow K\Sigma$ are considered. The superconvergent sum rules involving linear combinations of forward elastic scattering amplitudes of these processes are set up and tested. (auth)

50402 BARYON RESONANCES AND REGGE TRAJECTORIES. Spector, Richard M. (Wayne State Univ., Detroit). Phys. Rev., 173: 1761-3(Sept. 25, 1968).

The curves of imaginary spin versus mass squared are plotted from the experimental data for the Δ_δ and N_γ baryon resonances. These are found to be straight lines that satisfy a consistency condition imposed by the theory. The Chew-Frautschi plot is then calculated by means of a dispersion relation, using the imaginary-spin curve previously obtained. The resulting real-spin curve very nearly reproduces the standard straight-line fit in the region of the resonances. (auth)

50403 HARMONIC-OSCILLATOR MODEL FOR BARYONS. Faiman, David; Hendry, Archibald W. (Univ. of Illinois, Urbana). Phys. Rev., 173: 1720-9(Sept. 25, 1968).

Attention is drawn to a possible band structure displayed by the known N* resonances. The observed spectrum is similar to that predicted by a paraquark harmonic-oscillator shell model. Exact three-body Schrödinger wave functions are used to compute the Nπ and $\Delta\pi$ partial decay widths, assuming the pion emission

takes place via a one-quark de-excitation. The agreement with experiment is very good. (auth)

50404 RESCATTERING MODEL APPLIED TO Y* PRODUCTION. Singh, C. P.; Agarwal, B. K. (Allahabad Univ., India). Phys. Rev., 173: 1611-14(Sept. 25, 1968).

The production angular distributions for $Y_1^*(1385)$, $Y_0^*(1520)$, and $Y_1^*(1660)$ in K^--p scattering are characterized by forward and backward peakings. As the single-particle-exchange model is unable to account for these features, an attempt was made to explain them by considering rescattering square diagrams. It is found that the use of a coincident-pole method leads to a simple prescription for evaluating the production angular distributions. The results show agreement with the observed data when spin-parity assignments are $3/2^+$ for $Y_1^*(1385)$ and $3/2^-$ for $Y^*(1520, 1660)$. (auth)

50405 SUPERCONVERGENCE OF MESON-NUCLEON INVARIANT SCATTERING AMPLITUDES. Zovko, N. (Ruder Boskovic Inst., Zagreb). Z. Phys., 216: 194-203(1968).

Using two models, i.e., perturbation theory with the usual PS–PS Hamiltonian and a "relativistic" version of the Lee model with the same type of interaction, the question of superconvergent amplitudes in the (π,K) meson-nucleon forward scattering was studied. Does the impressive validity of the well-known sum rule for the $B^{(+)}$ amplitude make a serious support of the assumed superconvergence (because B describes the spin-flip scattering)? Indications, obtained from perturbation theory, including all Feynman diagrams up to the sixth order in the coupling constant and from the Lee model, where all allowed diagrams can be summed up, do not support the superconvergence assumption. Therefore the impressive prediction of the $B^{(+)}$ amplitude sum rule seems to be accidental. (auth)

50406 ELASTIC UNITARITY AND PHASE EQUALITY OF SCATTERING AMPLITUDES. Giovannini, A. (Univ., Turin, INFN, Turin); Predazzi, E.; Selleri, F. Phys. Rev., 173: 1660-3(Sept. 25, 1968).

Recently Törnqvist suggested that πN scattering below the inelastic threshold is compatible with the assumption that the phases of the $1/2$ and $3/2$ isospin amplitudes differ by $n\pi$. It is shown in the scalar case that this phase relation cannot hold over the whole angular interval; for elastic unitarity would then, in general, force the two amplitudes to have equal moduli also. (auth)

50407 EXTRACTING THE PHASE OF SCATTERING AMPLITUDES BY MEANS OF THE GLAUBER FORMULA. Vander Velde, J. C. (Univ. of Michigan, Ann Arbor). Phys. Rev., 173: 1544-8(Sept. 25, 1968).

A method is presented for extracting information on the phases of πp and πn scattering amplitudes by comparing data on πd scattering with the prediction of the Glauber formula. The essential feature of the analysis is the ability to write down the phase of the double-scattering term in terms of the phases, and their first derivatives, of the free π-nucleon amplitudes. The method is equally applicable to other beam particles (K,p,...) scattering off deuterons. A correction to the standard interpretation of the Glauber formula as applied to total cross-section defects is also given. (auth)

50408 STATISTICAL MODEL FOR HIGH-ENERGY REACTIONS. Foldy, L. L. (Case Western Reserve Univ., Cleveland); Kottler, H.; Speiser, D. R.; Weyers, J. Contracts AT(11-1)-1573; AT(30-1)-3829. Phys. Rev., 173: 1517-23(Sept. 25, 1968). (NYO-3829-23).

A statistical model for high-energy reactions is constructed, using the internal-symmetry invariance properties of the scattering amplitudes, which yields simple predictions for average branching ratios. The model is so constructed as to be applicable no matter what invariance group or reaction one considers, and also to yield results which are independent of the channel through which one views the reaction. Branching-ratio predictions are made for reactions of the type baryon + meson → baryon + meson and photon + baryon → meson + baryon. (auth)

50409 T = O, J = O PION–PION INTERACTION. Ellison, G. W.; Humble, S. (Trinity Coll., Dublin). Phys. Rev., 173: 1563-7(Sept. 25, 1968).

A recent analysis of the process $\pi^-p \to \pi^+\pi^-n$ at energies close to threshold suggests that the T = J = 0 pion-pion phase shift δ_0^0 may have a turnover behavior, starting off as a negative phase shift (with scattering length $\sim -1.7\mu^{-1}$) but soon turning over and becoming positive. The πN partial-wave "discrepancy" analysis is examined to find whether it is consistent with this kind of phase shift. The ABC effect is discussed briefly, and some possible consequences of a Castillejo-Dalitz-Dyson pole are suggested. (auth)

Strong (Baryon No. ≥ 2)

Refer also to abstract 50321.

50410 REGGE CUTS, THE WU–YANG HYPOTHESIS, AND THE COMPOSITE NATURE OF ELEMENTARY PARTICLES. Pinsky, S.; Trefil, J. S. (Massachusetts Inst. of Tech., Cambridge). Contract AT(30-1)-2098. Phys. Lett., 27B: 518-20 (Sept. 16, 1968).

It is shown that by combining the Abarbanel–Drell–Gilman statement of the Wu-Yang hypothesis (Phys. Rev. Letters, 20: 280 (1968)) with the idea that the p-p amplitude at large t is dominated by Regge cuts, predictions are obtained for the large t dependence of both the p-p amplitude and the hadronic matter distribution of the proton by assuming that this distribution is the same as the electromagnetic distribution. It is also shown that data on the proton form factor and the large angle p-p scattering are consistent with the Wu-Yang hypothesis. (L.B.S.)

50411 SPIN AND ISOSPIN IN HIGH-ENERGY CHARGE-EXCHANGE REACTIONS ON DEUTERONS. Ebel, G.; Pilkuhn, H. (Univ., Karlsruhe, Ger.). Nucl. Phys., B7: 147-59(1968).

The Glauber corrections for $\pi^+d \to ppx$ reactions are discussed, including spin-flip amplitudes. For the reaction $\pi^+d \to pp\eta$ the corrections are evaluated at 5.1 GeV/c. (auth)

50412 POLARIZATION IN p–p SCATTERING CLOSE TO 20 MeV. Breit, G.; Seamon, R. E. (Yale Univ., New Haven). Phys. Rev. Lett., 21: 760-1(Sept. 9, 1968). (YALE-1807-42).

The p-p polarization corresponding to Y-IV fits is compared with recent Saclay measurements and values in the Saclay paper obtained from recent Livermore fits. Agreement of the Saclay measurements with Y-IV is freer of systematic deviations than in the Saclay paper with Livermore, accentuating doubts expressed by the Livermore group concerning compatibility of Berkeley polarized-target results with other scattering measurements. (auth)

50413 RADIATIVE PION CAPTURE AND THE PION–NUCLEUS VERTEX FUNCTION. Griffiths, David; Kim, C. W. (Johns Hopkins Univ., Baltimore). Phys. Rev., 173: 1584-6 (Sept. 25, 1968).

The Kroll-Ruderman theorem and the elementary-particle treatment of the nucleus are used to calculate s-wave capture rate of pions by ^{3}He and ^{6}Li. The results are compared with previous estimates and experiment. The observed Panofsky ratio is also used to study the π^3He^{3}H vertex function. (auth)

50414 ELASTIC SCATTERING FROM DEUTERIUM. Pumplin, Jon (Univ. of Michigan, Ann Arbor). Phys. Rev., 173: 1651-9(Sept. 25, 1968).

Scattering of elementary particles from deuterons at BeV energies is considered. Corrections to the Glauber theory, resulting from violations of its high-energy and small-momentum-transfer assumptions, are found significant for experiments already performed. The most important correction results from including the principal-value part of the propagator in double scattering. Triple and higher-order multiple scattering are calculated in a model and are predicted to be important at momentum transfers of $-t > 4$ BeV^2. Available data on the energy dependence of the "screening correction" to deuteron total cross sections are shown to disagree with the Glauber theory, and a possible phenomenological treatment of that disagreement is discussed. (auth)

50415 p–p AND e–p ELASTIC SCATTERING AT LARGE MOMENTUM TRANSFERS. Greco, M. (CNEN, Frascati, Italy). Phys. Lett., 27B: 578-80(Sept. 30, 1968).

A different approach to the problem of connecting the p-p and e-p elastic scattering data is presented. The method consists of identifying asymptotically the square of the electromagnetic form factor $G_{Mp}(t)$ with the probability $P_{Nn}(t)$ that a proton does not break up at momentum transfer t. (L.B.S.)

50416 HIGH-ENERGY MULTIPLE SCATTERING FOR LARGE ANGLES. Ross, D. K. (Stanford Univ., Calif.). Phys. Rev., 173: 1695-9(Sept. 25, 1968).

A formalism for high-energy multiple scattering is presented which is similar to the Glauber approach but which replaces the small-angle approximation by the larger-angle theory of Schiff. This formalism is applied to the scattering of fast protons from ^{4}He with a very simple model, and Glauber's small-angle approximations are shown to be accurate only out to about 6° for an incident momentum ≈1BeV/c. A more realistic model using simple harmonic oscillator S waves for the nuclear wave functions is then shown to fit the recent 1-BeV scattering data of Palevsky et al. quite well even at the maximum which occurs at $q^2 = 9.4$ fm^{-2}, where the simple Glauber approach falls short.

Using modified nuclear wave functions and the Glauber formalism, Bassel and Wilkin can also fit this maximum. A good fit is obtained by improving the basic scattering theory, rather than by using a small-angle theory at fairly large angles and then modifying the nuclear model. (auth)

50417 DETERMINATION OF THE NUCLEON–NUCLEON SCATTERING MATRIX. IX. (n,p) ANALYSIS FROM 7 TO 750 MeV. MacGregor, Malcolm H.; Arndt, Richard A.; Wright, Robert M. (Univ. of California, Livermore). Phys. Rev., 173: 1272-1301(Sept. 25, 1968).

Papers VII and VIII in this series contained phase-shift analyses of (p,p) data from 0–400 MeV and from 0–750 MeV, respectively. The present paper gives the corresponding (n,p) analyses. In the energy region below 400 MeV, six single-energy analyses were carried out, as well as an energy-dependent analysis. The combined (p,p) plus (n,p) energy-dependent analysis below 400 MeV includes 839 (p,p) data and 912 (n,p) data. With 45 phenomenological parameters representing 14 free isovector phases and 11 free isoscalar phases, is obtained a solution that yields an average χ^2 per datum of 1.08 for the 1751 data. This solution gives a precision fit to the data from 400 down to 4 MeV, and it extrapolates well above 400 MeV. At energies below 50 MeV, it is found that the existing (n,p) data are not yet complete enough to permit a unique determination of the isoscalar phases. Single-energy analyses were also carried out at 425 and 630 MeV, as well as a combined (p,p) plus (n,p) energy-dependent analysis from 0 to 750 MeV. The energy-dependent solution, which includes 53 phenomenological parameters that represent 25 free phases, was obtained by fitting 1147 (p,p) data from 23 to 736 MeV and 901 (n,p) data from 14 to 730 MeV. It has an average χ^2 per datum of 1.34 for the 2048 data. However, at energies above 450 MeV, where, as shown in Paper VIII, the isovector amplitudes are not well known; the isoscalar amplitudes cannot be uniquely defined. Nevertheless, the restriction on the phases imposed by fitting to experiments near 425 and 630 MeV furthers the knowledge of the phase shifts at lower energies. It is found that the $^1P_1$ and $^3D_2$ phases exhibit maxima in the magnitudes near 300 MeV, and that the $^1F_3$ phase is monotonic. Second-derivative and error matrices are tabulated for the single-energy solutions at 25, 50, 95, 142, 210, 330, and 425 MeV. These matrices, which represent the phase-shift solutions fitted to 683 (p,p) data and 572 (n,p) data, contain most of the physical content of the entire elastic nucleon-nucleon data collection. Fitting potential models to these matrices is essentially equivalent to fitting directly to the data. Computationally, using the matrices is vastly simpler. (auth)

50418 PARITY-VIOLATING INTERNUCLEON POTENTIAL. Fischbach, Ephraim Samuel. Philadelphia, Univ. of Pennsylvania, 1967. 89p.

Thesis.

The parity-violating internucleon potential, $V(\vec{r}_{12})$, induced by the weak interactions is derived and analyzed. It is shown how the matrix elements of the weak parity-violating Lagrangian density, $\mathcal{H}_{eff}^{p\to\gamma}(x)$, may be expressed in terms of products of one-hadron → one-hadron matrix elements of the strangeness-conserving hadronic weak currents $V_\lambda(x)$ and $A_\lambda(x)$, and how these matrix elements can be evaluated using CVC and PCAC. Off-mass-shell effects at the weak interaction and strong interaction vertices are considered in some detail. The one-pion-exchange contribution to $V(\vec{r}_{12})$, which presumably dominates $V(\vec{r}_{12})$ at low energies because of its long range, is analyzed in particular detail by use of a dynamical model of the weak NNπ vertex. The contribution of ρ-meson exchange is also discussed. (Disser. Abstr.)

Particle Invariance Principles and Symmetries

General

Refer also to abstract 50678.

50419 (DESY-68/39) STUDY OF THE THREE POINT FUNCTION OF THE VECTOR AND AXIAL VECTOR CURRENTS BY MEANS OF CURRENT ALGEBRA AND THE METHOD USED. Fabricius, K. (Physikalisches Staatsinstitut, Hamburg (West Germany)). July 1968. 50p. (In German). Dep.

The ideas of current algebra, the stronger assumption that SU(2) × SU(2) symmetry becomes exact for infinite momentum, and assumptions concerning pole dominance are applied to the three-point functions of the vector and axial vector currents of the group SU(2) × SU(2) and systematically exploited. It is shown that the three point functions in this approximation are described completely by the constants g_ρ, F_π and m_ρ. The Kawarabayashi–Suzuki relation does not follow. (auth)

50420 GENERALIZED SECOND-ORDER RELATIVISTIC WAVE EQUATIONS. I. Rafanelli, Kenneth (TRW Systems, Redondo Beach, Calif.). J. Math. Phys. (N. Y.), 9: 1425-8 (Sept. 1968).

A covariant second-order wave equation, free of subsidiary conditions, is deduced from the familiar linear relativistic wave equation for a free particle of arbitrary spin by use of the representation-invariant Lie algebra of O(4,1). The correspondence principle is used to interpret the physical content of this generalized equation, which explicitly admits Zitterbewegung and implies an inverse spin dependence for the rest energy. Without further assumption this generalized second-order equation is equivalent to the Klein–Gordon equation for the particular Lie algebras of the Dirac and Duffin–Kemmer rings. For higher spins the imposition of a subsidiary condition, understood via the Bargmann–Wigner analysis, extends the equivalence with the Klein–Gordon equation and explicitly displays the above mass spectrum. (auth)

50421 IRREDUCIBLE COREPRESENTATIONS OF GROUPS HAVING A COMPACT SIMPLE LIE GROUP AS A SUBGROUP OF INDEX 2. Mehta, M. L.; Srivastava, P. K. (CEN de Saclay, Gif-sur-Yvette, France). J. Math. Phys. (N. Y.), 9: 1375-89(Sept. 1968).

For all possible extensions $\mathfrak{G}$ of the compact simple Lie groups G, such that G be a subgroup of $\mathfrak{G}$ of index 2, those corepresentations of $\mathfrak{G}$ were determined in which unitary operators correspond to the elements of the subgroup G, antiunitary operators to its coset. It is found that any irreducible unitary representation of G can be extended to an irreducible corepresentation of $\mathfrak{G}$ in various ways. (auth)

50422 SCALAR PRODUCT FOR HARMONIC FUNCTIONS OF THE GROUP SU(2). Pandres, Dave Jr.; Jacobson, Donald A. (Douglas Advanced Research Labs., Huntington Beach, Calif.). J. Math. Phys. (N. Y.), 9: 1401-3(Sept. 1968).

A scalar product is defined which results in the single- and double-valued spherical harmonics spanning a seminormed linear vector space that carries all of the irreducible unitary representations of the group SU(2). The possibility of defining such a scalar product was indicated in a previous paper. A Hilbert space is derived from the seminormed space through a further construction involving equivalence classes of vectors. (auth)

50423 ON THE CONNECTION BETWEEN TWO MODELS OF THE NAMBU EQUATION. Rosen, S. P. (Purdue Univ., Lafayette, Ind.). Contract AT(11-1)-1428. Progr. Theor. Phys. (Kyoto), 40: 178-9(July 1968). (COO–1428–46).

Two models of the Nambu wave equation were previously constructed from commuting sets of boson operators. One of the models was based on a non-unitary representation of the Lorentz algebra, and the other was based on a unitary transformation. It is pointed out that there exists a similarity transformation between these two representations, and that this transformation gives rise to a simple correspondence between the properties of the two models. It is also shown that the origin of this relationship is to be found in the Lie algebra of SO(4,2). (L.B.S.)

50424 INTERNAL SYMMETRY CROSSING MATRICES FOR AN ARBITRARY COMPACT GROUP. Foldy, L. L. (Case Western Reserve Univ., Cleveland); Kottler, H. Contracts AT(11-1)-1573; AT(30-1)-3829. Ann. Phys. (N. Y.), 48: 541-78 (July 1968).

The general properties of the internal symmetry crossing matrices are derived for an arbitrary compact internal symmetry group. Special emphasis is placed on the definition of these matrices and on the interpretation of the reduced amplitudes which they relate. The relation between the crossing matrices and the Racah coefficients in the particular case of SU_2 is also discussed. (auth)

50425 NOTE ON NONLINEAR REALIZATIONS OF CHIRAL SYMMETRY. Sollfrey, William (Rand Corp., Santa Monica, Calif.). Phys. Rev., 173: 1805-6(Sept. 25, 1968).

The general solution is found for Weinberg's equation for the Lagrangian of chiral-symmetry breaking. The result is an elementary function, and in the particular case of a tensor of rank 2 the effect of the nonlinearity is to multiply the ordinary Lagrangian by a simple factor. (auth)

50426 O(4) SYMMETRY IN FEYNMAN AMPLITUDES. Iwasaki, Yoichi (Tokyo Univ.). Phys. Rev., 173: 1608-11 (Sept. 25, 1968).

It is shown that any Feynman amplitude of pole diagrams at zero invariant mass does indeed possess the O(4) symmetry and

that there are poles which do not correspond to real particles. (auth)

50427 S-MATRIX APPROACH TO INTERNAL SYMMETRIES. II. Roy, S. M. (Tata Inst. of Fundamental Research, Bombay). Phys. Rev., 173: 1671-9(Sept. 25, 1968).

An S-matrix formulation of internal symmetries reported in a previous paper is extended to the case of broken symmetries. It was shown before that crossing and unitarity can determine permitted internal symmetries by determining what constant real orthogonal matrices can diagonalize an S matrix. It is shown that a generalization of the S-matrix diagonalization postulate which corresponds to patterns of symmetry breaking is an S-matrix stationary principle. In a calculation retaining only first-order deviations from the limit of exact symmetry, it is shown that crossing and unitarity determine what linear relations between S-matrix elements can remain stationary under a perturbation from the symmetry limit. Amplitude relations of conventional broken symmetries are thus derived for the breaking of isotopic-spin symmetry and unitary symmetry in the scattering of pseudoscalar mesons from pseudoscalar mesons. The application of unitarity on these amplitude relations leads to elegant derivations of mass formulas. (auth)

50428 SUBSTITUTION GROUP AND THE MIRROR REFLECTION SYMMETRY OF THE GROUP SU_3. Alishauskas, S. I.; Yutsis, A. P. (Inst. of Physics and Mathematics, Vilnyus, USSR. Kapsukas State Univ., Vilnyus, USSR). Liet. Fiz. Rinkinys, Liet. TSR Mokslu Akad., Liet. TSR Aukst. Mokyklos, 7: 541-52(1967). (In Russian).

The substitutions of the representation parameters of SU_3 under which the proper values of Casimir operators are invariant have been found. This set of substitutions is isomorphic to the Weyl group and it is proposed to call it substitution group of the representations parameters of the group SU_3. The phase relations of the basic functions and Clebsch–Gordan coefficients have been found. The mirror reflection symmetry of the group SU_2 has been generalised to the case of the group SU_3 and corresponding phase relations have been established. The geometrical interpretation of the mirror reflection has been proposed. (auth)

50429 GALILEAN SYMMETRY AND QUANTUM MECHANICS. Voisin, Jacques (Univ. Bujumbura, Burundi). Mem. Acad. Roy. Belg., Cl. Sci., Coll. 8, 38: 1-212(1968). (In French).

The fundamental principles of Galilean symmetry are summarized. The Galilei group and its Lie algebra are reviewed. Galilean symmetry and its quantum formulation are illustrated. The true and projective irreducible representations of the Galilei group and that in different bases are constructed. The two-particle systems of nonzero mass, positive or negative, and eventually opposite, are studied. Some basic concepts on the Lie groups and a presentation of the concept of projective representations in the general framework of the problem of the extensions of one group by another group are given. (J.S.R.)

Applications (Electromagnetic and Weak)

Refer also to abstract 50286.

50430 A NEW METHOD FOR DERIVING RELATIONS FOR BARYON MASSES. Zaitsev, R. G. (Inst. of Physics, Sofia). Compt. Rend. Acad. Bulg. Sci., 21: 319-21(1968). (In Russian).

A new method for obtaining functions between baryon masses in unitary symmetry SU(3) which is not related directly to the perturbation theory was suggested by V. G. Kadyshevskii (Doklady Akad. Nauk SSSR, 172, 73, 1967). The work also offers the assumption that the mass operator is diagonal to the isospin and the hypercharge. The quark masses π,ν are equal but differ from quark mass λ, and for the SU(3) group in the ν and λ space at the angle of $\theta = \pi/4$ the deflection is turned in such a manner that the ν' and λ' quarks have identical mean masses equal to the average mass of ν and λ. An attempt was made to establish that such states in the given multiplet u' have identical electric charge Q and those which have identical absolute magnitude (u_3') have also identical mean masses. An additional postulate is suggested stating that generally the states in the given u' multiplet have identical masses. This is done with the purpose of obtaining relations between real masses (i.e., nontransformed baryons). The additional postulate was verified by comparison of the relations between the masses and the data obtained by observations. (R.V.J.)

50431 WEAK INTERACTIONS AND SYMMETRIES. D'Espagnat, B. (Paris Univ., Orsay, France). pp 135-218 of Advances in Particle Physics. Vol. I. Cool, R. L. (ed). New York, John Wiley and Sons, Inc., 1968.

The recent applications of group theory, and particularly of unitary symmetry, to the problem of the weak interactions are described. A brief review is first given of the main experimental aspects concerning the semileptonic $\Delta S = 0$ interactions, nonleptonic $\Delta S = 0$ interactions, semileptonic $\Delta S \neq 0$ interactions, and $\Delta S \neq$ nonleptonic interactions. Some of the formulas and assumptions which play a basic role in all theories on weak interactions are then summarized in section II. Section III includes a short, elementary description of how groups are used to describe internal symmetries and an account of some important new results on currents and renormalizations that do not depend on particular group symmetries. The remaining sections treat the symmetry properties of the weak interactions. (L.B.S.)

Applications (Strong)

50432 HIGHER SYMMETRIES OF HADRONS. Sakita, Bunji (Argonne National Lab., Ill.). pp 219-94 of Advances in Particle Physics. Vol. I. Cool, R. L. (ed). New York, John Wiley and Sons, Inc., 1968.

An introductory survey of the symmetries of hadrons includes discussions on charge independence, Fermi-Yang model, strange particles, Sakata model, eightfold way and quarks, Wigner's supermultiplet theory of the nucleus, and supermultiplet theory of hadrons. The remaining topics discussed are: consequences of the SU(3) and SU(6) symmetry; problems of relativization of SU(6); and phenomenological approach to relativistic SU(6). 86 references. (L.B.S.)

50433 REPRESENTATIONS OF GAUGE GROUP AND INFINITE MULTIPLETS OF HADRONS. Gliozzi, F. (Univ., Turin). Nuovo Cim., 57A: 457-67(Oct. 1, 1968).

New representations are found of the infinite parameter gauge group generated by an internal symmetry group G (SU_2 or SU_3 for instance) by allowing its elements to be arbitrary functions of space-time. The pattern of quantum numbers characterizing these representations is very similar to that displayed by representations of current algebra at infinite momentum. More precisely, the spin content can be described as an infinite sequence of integrally rising integer or half-integer spins, while the G-dependence turns out to have two different behaviors: the first one corresponds to the Kronecker product of an arbitrary number of G representations; the second one can be expressed as an infinite sequence of G multiplets. (auth)

50434 RADIATIVE DECAY OF BOSON RESONANCES. Barut, A. O.; Tripathy, K. C. (Univ. of Colorado, Boulder). Nucl. Phys., B7: 125-32(1968).

The partial decay rates of higher-spin boson resonances B^* for the process $B^* \rightarrow B + \gamma$ were evaluated in a model in which the higher spin boson states at rest are assigned to a representation of the dynamical group O(4,2). (auth)

50435 BARYON RESONANCES AND SU_3 MIXING. I. $N^*(1400)$. Halzen, Francis; Konuma, Michiji (Univ. of Louvain. Kyoto Univ.). Progr. Theor. Phys. (Kyoto), 40: 99-113 (July 1968).

The increase of the number of baryon resonances reveals a new feature that there are several resonances which have common isospin, hypercharge, spin and parity. This situation calls for the treatment of reducible representations of SU_3 for the classification of the baryon resonances. In the reducible representation which has to do with these resonances two or more tensor components appear which are connected with the same isospin and hypercharge. In such a case the physical baryon fields are in general expressed as linear combinations of these tensor components. The baryons with spin $S = \frac{1}{2}$ and positive parity are treated. In addition to the usual octet, a pion-nucleon resonance P_{11}, $N^*(1400)$ or the so-called Roper resonance (mass $\approx$1400 MeV, $I = \frac{1}{2}$, $Y = 1$) is experimentally observed. Taking into consideration this resonance, the $8 + 8$ or $8 + 10^*$ or $8 + 27$ is used to describe the baryons with $S^P = \frac{1}{2}^+$. The mass formula and the transition between the $\frac{3}{2}^+$ baryon and the $\frac{1}{2}^+$ baryon with an emission of a pion are discussed by adopting the effect of the mixing. The possibility $8 + 10^*$ is excluded through an analysis of the decuplet decay. In order to distinguish between the other two possibilities the present experimental data are not enough. The most interesting case $8 + 8$ is discussed in detail. (auth)

50436 RATE OF $A_1 \rightarrow \rho\pi$ FROM ASYMPTOTIC CHIRAL SYMMETRY. Zee, A. (Harvard Univ., Cambridge, Mass.). Phys. Rev., 173: 1788-90(Sept. 25, 1968).

By assuming that $SU(2) \times SU(2)$ symmetry is approached at large momentum transfer and using a crude pole approximation, the $A_1 \rightarrow \rho\pi$ decay amplitude is determined. The ratio of $\Gamma(A_1 \rightarrow \rho\pi)$ to $\Gamma(\rho \rightarrow \pi\pi)$ is predicted to be about 2 or $\frac{1}{2}$, depending on a further assumption. However, as pointed out by Schwinger, it is conceivable that the total A_1 width may be considerably smaller than the width for $A_1 \rightarrow \rho\pi$. The ratio of s- to d-wave

decay is different for the various known approaches and may be decided on by polarization and angular measurements. Brief remarks are given on the relationship of asymptotic chiral symmetry to current algebra. (auth)

50437 SOME REMARKS ABOUT DYNAMICAL ASYMMETRY. Pais, A. (Rockefeller Univ., New York). Phys. Rev., 173: 1587-95(Sept. 25, 1968).

Model equations are studied for the purpose of gaining some understanding about the possible origins of strong SU(3) breaking. The equations are response equations in the octet space of SU(3). They have full SU(3) symmetry apart from electromagnetic and weak driving terms. A class of equations is described for which, amongst others, solutions exist such that (1) they are tilted with respect to the plane defined by the driving forces, thereby generating the formal equivalent of a Cabibbo angle, and (2) large asymmetries occur in a direction which is the one of hypercharge up to electromagnetic corrections. (auth)

50438 BROKEN-SYMMETRY MODEL OF MESON INTERACTIONS. Copley, L. A.; Elias, D. K.; Masson, D. (Univ. of Toronto). Phys. Rev., 173: 1552-63(Sept. 25, 1968).

The SU(3) extension of the $\lambda\phi^4$ model is investigated using both group-theory methods and Padé approximants applied to third-order perturbation theory. The model is shown to possess a higher symmetry O(8). The implications of O(8) symmetry and the Padé-approximant calculation are discussed and compared. (auth)

Field Theories

General

50439 BROKEN-SYMMETRY CONDITION FOR FERMION FIELDS. Swieca, J. A. (Univ. of Sao Paulo, Brazil). Nuovo Cim., 57A: 573-7(Oct. 1, 1968).

The possibility of imposing a broken-symmetry condition on fermion fields analogous to the one for boson fields is investigated. It is shown that, besides the trouble with Lorentz invariance, the broken-symmetry condition $\langle 0|\psi_{\alpha}(x)|0\rangle \neq 0$ is incompatible with a positive definite metric in the Hilbert space. (L.B.S.)

Quantum Field Theory

Refer also to abstract 50283.

50440 PERTURBATION EXPANSION IN QUANTUM ELECTRODYNAMICS. Edin, Karl Axel; Peressutti, Giorgio (Inst. of Theoretical Physics, Goteborg). Ark. Fys., 35: 499-512 (1968).

The Schwinger–Dyson equations were studied within a perturbative scheme and in a closed electrodynamic system of photons and electrons in the approximation with bare vertex. This was accomplished by using a special gauge where the renormalization constant Z_2 is finite and equal to one. A form for these equations suitable for numerical calculations was derived and some general results for the photon and fermion Green's functions in the asymptotic and in the infrared regions were given. It is shown that the use of the bare vertex approximation in the Schwinger–Dyson equations is compatible with the Ward–Takahashi identity. (Swed)

50441 COMPOUND FIELDS OF INFINITE MULTIPLETS. Cao Chi; Nguyen van Hieu (Joint Inst. for Nuclear Research, Dubna, USSR). Dokl. Akad. Nauk SSSR, 180: 832-5(June 1, 1968). (In Russian).

The G = P · S symmetry group, the half-line product of a Poincaré group P and of the noncompact internal symmetry group S containing the subgroup SL(2,C) has been proposed to generalize the SU(6) symmetry group. The symmetry properties and the unitary conditions of the S matrix are compatible in such a theory involving infinite multiplets. In order to introduce quantized fields characterizing this infinite multiplet, an infinite number of spinor fields must be introduced. The calculations showed that the causality principle requires a Bose quantization of large fields, regardless of their spin content, agreeing with the conclusions reached by G. Feldman and P. T. Mathews. Consideration of the interaction of the infinite multiplets with singlet fields yielded an expression of the matrix elements for the scattering and annihilation channels. (TTT)

50442 CONTRIBUTIONS TO THE THEORY OF THE FREE 2(2s + 1)-COMPONENT, QUANTIZED SPINOR FIELDS. Khodzhaev, L. Sh. (Joint Inst. for Nuclear Research, Dubna, USSR). Dokl. Akad. Nauk SSSR, 180: 824-7(June 1, 1968). (In Russian).

A functional group theory formalism of free 2(2s + 1)-component, quantized fields was derived in order to examine the covariant structure of the elements of the causative S matrix for an arbitrary spin. In order to determine these free spinor fields as general operator functions, a Hilbert space induced by irreducible [ms] representation of Poincare spinor group $\tilde{P}_+$ ↑ for a particle with mass m and spin s, was examined. The state of the system was described by means of vectorial generalization of the space of linear, continuous functionals in the nuclear space. (TTT)

50443 PHOTON PROPAGATORS IN QUANTUM ELECTRODYNAMICS. Yokoyama, Kan-ichi (Hiroshima Univ.). Progr. Theor. Phys. (Kyoto), 40: 160-6(July 1968).

Quantum electrodynamics in the Landau gauge is investigated in a different manner from Nakanishi's theory. A dipole ghost field is introduced in another simple way. It is shown that the Landau gauge representation can be obtained by a unitary transformation from the usual Feynman gauge representation. The two representations are equivalent to each other, though photon propagators take different forms superficially in each case. Supplementary conditions to eliminate the ghost states are discussed with the Lorentz condition. It is asserted that the interaction picture in the Landau gauge is also possible. (auth)

50444 DUALITY BETWEEN THE FEYNMAN INTEGRAL AND A PERTURBATION TERM OF THE WIGHTMAN FUNCTION. Minami, Masatsugu; Nakanishi, Noboru (Kyoto Univ.). Progr. Theor. Phys. (Kyoto), 40: 167-77(July 1968).

Graph-theoretical consideration is made to find a duality relationship between the position space and the momentum space. It is shown that, given a Feynman graph, there can be constructed, if it is planar, the position-space perturbation example (Wightman function) which has the same singularity region (in position space) as that (in momentum space) of a mass-superposition of the Feynman integral corresponding to the given graph. On the basis of this result, A.C.T. Wu's conjecture on the analyticity of the four-point Wightman function is criticized. (auth)

50445 REDUCTION OF THE BETHE–SALPETER EQUATION FOR A ZERO-MASS SYSTEM. Keam, R. F. (Univ. of Auckland, N. Z.). J. Math. Phys. (N. Y.), 9: 1462-7(Sept. 1968).

The ladder-approximation Bethe–Salpeter equation for a bound spin-½ fermion-antifermion system of zero total mass is reduced in the general case to coupled radial equations for general radial potential functions. Symmetries of the radial equations are also demonstrated. (auth)

50446 HAAG THEOREM FOR THE POINT-COUPLING RELATIVISTIC LEE MODEL. Yndurain, F. J. (New York Univ.) J. Math. Phys. (N. Y.), 9: 1423-4(Sept. 1968).

It is proved that the free and total (renormalized) Hamiltonians exist as essentially self-adjoint operators in the relativistic Lee model without cutoff. Nevertheless, their domains of definition only have the zero vector in common and thus the interaction Hamiltonian is meaningless ("Haag's theorem"). (auth)

50447 LORENTZ COVARIANT DISTRIBUTIONS. Yndurain, F. J. (New York Univ.) J. Math. Phys. (N. Y.), 9: 1415-22 (Sept. 1968)

Tensor distributions of several four-vector variables which transform according to a finite representation of the Lorentz group are considered. A canonical classification is given of all possible forms of such objects; this is used to show that, in the relevant cases, it is sufficient to regularize them with respect to the invariants that may be formed out of the variables to obtain analytic functions. This result is applied to Wightman functions, showing a result similar to a theorem proved in position space by Borchers under different assumptions. (auth)

50448 ANALYTIC RENORMALIZATION. Speer, Eugene R. (Princeton Univ., N. J.). J. Math. Phys. (N. Y.), 9: 1404-10 (Sept. 1968).

Renormalized Feynman amplitudes are defined by a method of analytic continuation in subsidiary parameters. The results are shown to belong to the class of renormalized amplitudes defined by Boguliubov, Parasiuk, and Hepp. (auth)

50449 ASYMPTOTIC ESTIMATES OF FEYNMAN INTEGRALS. Fink, James P. (Stanford Univ., Calif.). J. Math. Phys. (N. Y.), 9: 1389-1400(Sept. 1968).

The problem of determining logarithmic, as well as polynomial, asymptotic estimates for certain convergent integrals containing parameters is considered. An asymptotic theorem is stated and proved which gives the logarithmic asymptotic behavior of a convergent integral where any subset of the parameters becomes large while the remaining parameters remain bounded. This theorem is then applied to the photon and electron self-energy graphs of quantum electrodynamics. (auth)

50450 LORENTZ INVARIANCE, LOCAL FIELD THEORY, AND FASTER-THAN-LIGHT PARTICLES. Arons, M. E. (City

Univ. of New York); Sudarshan, E. C. G. Phys. Rev., 173: 1622-8(Sept. 25, 1968). (NYO-3399-133).

The quantum theory of faster-than-light particles is studied following the earlier classical theory of Bilanuik, Deshpande, and Sudarshan and of Terletski. The ingenious scheme of quantization formulated by Feinberg is seen, on closer examination, to violate Lorentz invariance. Another scheme of quantization involving a new physical postulate is formulated. The consistency and novel features of this formulation are discussed in some detail. (auth)

50451 THEORY OF CURRENTS, σ MODEL, AND THE SPHERICAL TOP IN THE INTERNAL SPACE. Sugawara, H.; Yoshimura, M. (Univ. of Chicago). Phys. Rev., 173: 1419-22(Sept. 25, 1968).

A Lagrangian field theory is constructed which gives a canonical realization of the recently proposed theory of currents. It is very similar to Gell-Mann and Levy's σ model, but with some crucial differences. It is the second-quantized theory of the spherical top in the internal space, thus implying some connection to the strong-coupling theory. (auth)

50452 COHERENT SOFT-PHOTON STATES AND INFRARED DIVERGENCES. II. MASS-SHELL SINGULARITIES OF GREEN'S FUNCTIONS. Kibble, T. W. B. (Univ. of Rochester, N. Y.). Phys. Rev., 173: 1527-35(Sept. 25, 1968). (UR-875-229).

This is the second in a series of four papers in which a new, field-theoretic approach to the problem of the infrared divergences of quantum electrodynamics is presented. The primary aim of the present paper is the study of the mass-shell singularities of the Green's functions, which are branch points rather than simple poles. This is an essential preliminary to the discussion of asymptotic states and scattering matrix elements in subsequent papers. A conventional separation is introduced between hard- and soft-photon regions of momentum space. It is shown that the soft-photon contribution to an arbitrary Green's function may be isolated in a single function of the external momenta, independent of the spins of the particles involved. An explicit expression for this function is obtained and its mass-shell singularities are studied in detail. In particular, it is shown that, in contrast to the case where there are no massless particles, the mass-shell singularities in different momenta are not independent, but depend on the order in which the various momenta are allowed to approach their mass shells. (auth)

50453 SOFT PHOTONS AND THE CLASSICAL LIMIT. Brown, Lowell S.; Goble, Robert L. (Yale Univ., New Haven). Contract AT(30-1)-2726. Phys. Rev., 173: 1505-16(Sept. 25, 1968).

The first two orders of the low-frequency limit of a bremsstrahlung amplitude are determined by the general principles of quantum field theory. The leading order is in obvious correspondence with the classical limit. A conceptual experiment is presented which shows that the next-order term is also determined by the classical limit. In addition, a generating functional is constructed that provides the two leading terms of the bremsstrahlung amplitude for the emission and absorption of an arbitrary number of soft photons. This generating functional is used to indicate a classical correspondence to all powers of the electrical charge. (auth)

50454 PROPERTIES OF THE GENERALIZED COHERENT STATE. Bialynicka-Birula, Z. (Polish Academy of Sciences, Warsaw). Phys. Rev., 173: 1207-9(Sept. 25, 1968).

Properties of the generalized coherent states of the electromagnetic field, introduced by Titulaer and Glauber, are investigated. It is shown that, in contradistinction to photon-counting measurements, the average value of the electromagnetic field and the electron scattering amplitudes depend on the detailed form of these states. (auth)

Gravitation and General Relativity

Refer also to abstract 50267.

50455 ELECTROMAGNETIC WAVE PROPAGATION IN THE SPACE WITH A METRIC OF A GRAVITATIONAL WAVE. Vodyanitskii, A. A.; Dimanshtein, F. A. (Kharkov State Univ.). Ukr. Fiz. Zh., 13: 1403-5(Aug. 1968). (In Russian).

Electromagnetic wave propagation in a space with Einstein's metric for plane gravitational wave was studied for electromagnetic detection of gravitational waves. The solution to Einstein's equation for a vacuum for weak gravitational field taken as a plane monochromatic wave (J. Weber Phys. Rev. 117, 306, 1960) propagating parallel to the OX axis was used as a gravitational wave metric. Along the same axis propagate electromagnetic waves. Solutions were obtained for the Maxwell equations for transverse electromagnetic waves with amplitudes proportional to the amplitudes of gravitational waves and frequencies equal to the sum or difference of frequencies of the initial electromagnetic and gravitational waves. (R.V.J.)

50456 A CLOSED FORM OF THE SPIN-VECTOR THEORY OF THE GRAVITATION FIELD. Treder, H.-J. (Forschungsgemeinschaft, Sternwarte Babelsberg, Ger.). Monatsber. Deut. Akad. Wiss. Berlin, 10: 40-3(1968). (In German).

A spin vector theory was previously proposed (Monatberichte, 9: 283(1967)) which includes gravitation as the weakest interaction in the unitary spinor field theory of the Heisenberg type. The derivability of the field equation of the spin-vector theory from the unitary variation principle is discussed. (J.S.R.)

50457 WHAT IS A SINGULARITY IN GENERAL RELATIVITY? Geroch, Robert (Princeton Univ., N. J.). Ann. Phys. (N. Y.), 48: 526-40(July 1968).

The general covariance of relativity theory creates serious difficulties in formulating a suitable definition of a singularity in this theory. The arguments which lead from one's intuitive picture of a singularity as "some quantity's becoming infinite" to the notion of geodesic completeness are examined. Possible definitions based on geodesic completeness are also examined. It is claimed that none of these definitions is entirely satisfactory. (auth)

50458 ISOTROPIC SOLUTIONS OF THE EINSTEIN-LIOUVILLE EQUATIONS. Ehlers, J.; Geren, P.; Sachs, R. K. (Univ. of Texas, Austin). J. Math. Phys. (N. Y.), 9: 1344-9(Sept. 1968).

The gravitational field generated by a gas whose one-particle distribution function obeys the Liouville equation is examined under the following assumptions: First, the distribution is locally isotropic in momentum space with respect to some world-velocity field; second, if the particles have rest-mass zero, the gas is irrotational. It is shown that the model is then either stationary or a Robertson-Walker model. The time dependence of the radius in the Robertson-Walker models is given in terms of integrals containing the distribution function. (auth)

50459 ON THE GREEN'S FUNCTION IN AN EXPANDING UNIVERSE AND ITS ROLE IN THE PROBLEM OF MACH'S PRINCIPLE. Nariai, Hidekazu (Hiroshima Univ.). Progr. Theor. Phys. (Kyoto), 40: 49-59(July 1968).

In view of an equal qualification of Brans and Dicke's gravitational theory of Einstein's general theory of relativity on an experimental level, the problem of Mach's principle, fundamental in the former theory, is studied by the use of the retarded bi-scalar Green's function for their inertial field ϕ in a homogeneous and isotropic universe. After deriving concretely the relevant Green's function, we show that Brans and Dicke's cosmology is compatible with their stipulation of Mach's principle, with some proviso about the radiation universe in which the trace of the energy-momentum tensor is vanishing. (auth)

50460 RELATIVISTIC PARTICLE-ANTIPARTICLE STATIONARY STATES IN A MODEL QUANTUM FIELD THEORY: MESONS FROM QUARKS. Rosen, Gerald (Drexel Inst. of Tech., Philadelphia). Phys. Rev., 173: 1680-4(Sept. 25, 1968).

Relativistic two-quantum particle-antiparticle bound states and scattering states are derived in a renormalized complex scalar field theory model which features a Heisenberg-type self-interaction term $\lambda_0(\psi^*\psi)^2$ in the Lagrangian. The analysis is based on the Rayleigh-Ritz procedure for functionalities — a nonperturbative solutional method requiring the assumption that physically reasonable stationary states exist in the model. It is shown that the mass of a particle-antiparticle bound state can be one or more orders of magnitude less than the mass associated with a one-particle state. This property of the model suggests that a Heisenberg-type theory for a self-interacting quark spinor field may yield a physically realistic quark-antiquark meson with a mass one or two orders of magnitude less than the mass of a constituent quark. (auth)

50461 SELF-CONSISTENT HOMOGENEOUS ISOTROPIC COSMOLOGICAL MODELS. I. GENERALITIES. Hakim, Remi (Faculte des Sciences, Orsay, France). Phys. Rev., 173: 1235-42(Sept. 25, 1968).

Self-consistent models of uniform universes are provided by coupling Einstein's equations to the one-particle Liouville equation. Correlations between the "particles" of the cosmic gas are thus neglected. As a consequence, an equation of state is not needed in the theory but is, rather, provided from these statistical considerations. It is shown that an expanding self-consistent uniform universe behaves asymptotically as the relativistic polytrope $p \sim \mu^{\frac{4}{3}}$, and finally, as an expanding Friedmann universe. Near the possible singularity R = 0 (R = scale factor), self-consistent models are hot models. Friedmann models are shown to be a particular case of self-consistent models. (auth)

50462 GRAVITATIONAL COLLAPSE OF ROTATING BODIES. Cohen, Jeffrey M. (Goddard Space Flight Center, New York). Phys. Rev., 173: 1258-63(Sept. 25, 1968).

The effect of gravitational collapse of rotating bodies on the induced rotation of inertial frames is investigated. In particular, it is shown that the angular velocity of the inertial frames, within an adiabatically collapsing, slowly rotating mass shell supported by elastic stresses, approaches that of the shell as the shell radius approaches the Schwarzschild radius. Even when this relative angular velocity approaches zero, the angular momentum (a conserved quantity) does not vanish; it remains constant during the collapse. On the other hand, an observer within a slowly rotating dust shell (at the point of maximum expansion) does not see the angular velocity of the inertial frames approach that of the shell as the radius approaches the Schwarzschild radius. This difference between the two situations is shown to be in accordance with Mach's principle. The effect of rotation on gravitational collapse is also considered. This is done to shed some light on an important question in astrophysics: Does rotation stop collapse, or does collapse crush rotation? A spherical shell of dust supported by "centrifugal forces" is considered. It is shown that rotation cannot stop collapse unless the shell radius is equal to or larger than (9/8) × (Schwarzschild radius). This happens even though the velocity of the particles in the shell is allowed to approach that of light. (auth)

50463 SOURCES AND GRAVITONS. Schwinger, Julian (Harvard Univ., Cambridge, Mass.). Phys. Rev., 173: 1264-72 (Sept. 25, 1968).

Gravitational theory is reconstructed from the source description of gravitons. As indirect evidence for this starting point, the theoretical basis for the four tests of Einsteinian gravitational theory is produced by elementary arguments. Following the electromagnetic example, the source description is recast as a numerical field theory characterized by an action principle. After recognizing that the physically restricted theory possesses invariance with respect to infinitesimal coordinate transformations, it is generalized to exhibit invariance under arbitrary coordinate transformations, which supplies the primitive interactions for multigraviton processes. There is a discussion of the necessary dependence of graviton sources upon the gravitational field, and a simple model is constructed. The qualitative structure of the modification that multiparticle exchange introduces in the graviton-propagation function is exhibited, with the corresponding modification in the Newtonian potential. There are some speculative remarks about Mach's principle and the accompanying interpretation of the gravitational constant. The paper concludes by pointing out empirical scaling laws that interconnect the cosmos, the laboratory, and the atom. (auth)

50464 NEW LINEAR THEORY OF GRAVITATION. Gottlieb, I.; Mociutchi, C.; Segal, A.; Tatomir, D.; Teodorescu, V. An. Stiint. Univ. Al. I. Cuza Iasi, Sect. Ib. Fiz., 13: 5-12(1967). (In German).

A linear theory of gravitation is developed irrespective of the general relativistic considerations, starting from the following assumptions: a) the static gravitational field in linear approximation is described by Newton's theory; b) a linear theory of gravitation must be Lorentz-covariant and c) the source of the gravitational field is the heavy mass (proportional to the inert mass), which varies with the velocity according to Einstein's relation. By applying the results to the motion of planets it is found that the areolar velocity varies according to relation $A = \epsilon(1 - \mu/r)$; an expression is developed for the perihelion displacement which is half the real magnitude of this displacement. (TSS) (Rom. Sci. Abstr.)

Scattering Theory

50465 SOME CONSEQUENCES OF THE GEL'FAND–LEVITAN EQUATIONS. Sobel, M. I. (Atomic Energy Research Establishment, Harwell, Eng.). J. Phys., A (London), 1: 610-16(Sept. 1968).

The Gel'fand–Levitan equations for the solution of the inverse scattering problem were written in terms of the half-off-energy-shell matrix element. This element was given in terms of the phase shifts, by a double integral equation in which the kernel had simple poles. An integral equation for the wave function is also found. The effects of bound states are included, and a relation between the large and small r behavior of the bound-state wave function is found. (auth)

50466 INTEGRAL REPRESENTATIONS FOR N-PARTICLE FUNCTIONS. Stapp, H. P.; Wright, J. L. (Univ. of California, Berkeley). Nuovo Cim., 57A: 475-96(Oct. 1, 1968). (UCRL-17861).

An integral representation of the Bergman-Weil type is derived for a function defined on an algebraic variety. This formula is useful for constructing Mandelstam-type integral representations for N-particle functions. (auth)

50467 ANALYTICAL PROPERTIES OF THE SCATTERING MATRIX IN CASE OF ARBITRARY NUMBER OF CHANNELS. Tsekhmistrenko, Yu. V. (Inst. of Physics, Kiev). Ukr. Fiz. Zh., 13: 1192-7(July 1968). (In Russian).

On the basis of general physical principles of invariance with respect to time reflection, conservation of particle number and causality, the analytical properties of the multichannel S-matrix are established on an impulse complex plane. The S-matrix proved to be meromorphic on the physical sheet and a similar behavior of the S-matrix on the whole Riemannian plane is established by means of probable physical assumptions. The threshold singularities and structure of the resonance terms are examined. (auth)

50468 LARGE ANGLE QUASICLASSICAL SCATTERING AT HIGH ENERGIES. Pirogov, Yu. F. (Moscow Engineering-Physics Inst.). Zh. Eksp. Teor. Fiz., 55: 854-68(1968). (In Russian).

Some analytic properties of the scattering matrix as a function of the complex angular momentum are studied for nonrelativistic scattering on a Gaussian potential $U(r) = U_0 \exp(-r^2/a^2)$. The asymptotic behavior of the scattering amplitude for large momentum transfers is found. The possibility of a universal phenomenological description of the experimental data on high energy elastic pp-scattering throughout the whole angle range by means of a Gaussian potential is considered. (auth)

50469 DYNAMICAL SEPARATION OF THE RESONANCE TERM FROM THE BACKGROUND TERM. Kinoshita, K.; Kinoshita, Y. (Kyushu Univ., Fukouka). Nucl. Phys., B7: 121-4 (1968).

The multichannel amplitude containing a resonance is separated into the resonance term and the background term according to the dynamical situation which produces the resonance. (auth)

50470 THRESHOLD-BEHAVIOR REQUIREMENTS FOR P-WAVE N/D EQUATIONS. Cornille, H.; Rubinstein, G. (Institut de Physique Nucleaire, Orsay, France). J. Math. Phys. (N. Y.), 9: 1501-16(Sept. 1968).

For nonrelativistic P-wave N/D equations the two different cases are considered, depending on whether the solutions of the subtracted equations, assuring automatically the right threshold-behavior conditions, satisfy the unsubtrated equations or not. In both cases the meaning of the corresponding interactions is investigated. (auth)

50471 INFLUENCE OF REGGE ASYMPTOTICS ON THE DETERMINATION OF RESONANCE PARAMETERS. Alessandrini, V. A. (International Centre for Theoretical Physics, Trieste, Italy); Amati, D.; Squires, E. J. Phys. Lett., 27B: 463-5(Sept. 2, 1968).

A new method of determining resonance parameters through a new form of the interference model is suggested. (auth)

50472 ARGAND DIAGRAMS AND RESONANCES. Alessandrini, V. A.; Freund, P. G. O.; Oehme, R.; Squires, E. J. (International Atomic Energy Agency, Trieste, Italy). Phys. Lett., 27B: 456-9(Sept. 2, 1968).

It is shown that the Argand analysis of Regge amplitudes would give rise to "resonances" with low masses and high spins if the interpretation of maxima as resonances were accepted. Theoretical and experimental consequences are discussed. (auth)

50473 KINEMATIC SINGULARITIES AND CONSTRAINTS OF HELICITY AMPLITUDES. Trueman, T. L. (Brookhaven National Lab., Upton, N. Y.). Phys. Rev., 173: 1684-94(Sept. 25, 1968).

The kinematic singularities and constraints of helicity amplitudes are studied in a unified way. Relatively simple and compact formulas are obtained which enable one to read off the singularities and constraints for any particular two-body process. The points studied are the thresholds and pseudothresholds, $s = 0$, and the boundary of the physical region. The fundamental assumption which underlies the method used here is that all kinematic singularities result from singular definitions of the helicity states. (auth)

50474 ASYMPTOTIC ESTIMATE OF FORWARD DISPERSION RELATIONS IN THE PRESENCE OF REGGE CUTS. Yndurain, F. J. (CERN, Geneva). Phys. Lett., 27B: 581-5(Sept. 30, 1968).

The asymptotic behavior of forward dispersion relations is studied. An explicit estimate of the ratio ReT/ImT is deduced when Regge cuts are present. Its predictions are checked against experiment, with which they are compatible in the present energy range. (auth)

50475 SCATTERING MODEL WITH CROSSING SYMMETRY AND MINIMAL INELASTIC EFFECTS. Cheung, Franklin F. K.; Toll, John S. (State Univ. of New York, Stoney Brook). Phys. Rev., 173: 1791-1804(Sept. 25, 1968).

The iterative method of solving the dispersion relations and unitarity relations for the two-body scattering amplitude of a neutral scalar field is investigated. A consistent and nontrivial approximating scheme is obtained by incorporating enough inelastic effects that crossing symmetry is maintained at every stage of calculations. If one has initially a twice-subtracted dispersion relation, it can be shown that because of crossing symmetry, the subtraction term linear in s, t, and u cannot be present, so that it is sufficient to start the iteration process by just one subtraction. The unitarity relations are simplified by taking the scattering particle to have zero mass. Questions concerning infrared divergences and convergency properties in iterating the single and double density functions are fully discussed. At low energies, the amplitude is given by the first few iterations, which will be carried out explicitly to fourth order. Higher orders of iteration can be carried out in a straightforward but increasingly tedious manner. The behavior of the scattering amplitude is studied in the high-energy region, where s, t, and u are all large in magnitude, while the scattering angles are held at fixed values. The leading terms of the scattering amplitude and its spectral functions are obtained for each order of iteration, and the resulting leading series are subsequently summed into closed forms for weak coupling. The ratio of the elastic cross section to the total cross section is also obtained in the same region. The result indicates that the amount of inelastic effects being included is considerable. (auth)

50476 COVARIANT M FUNCTIONS FOR HIGHER SPIN. Scadron, M. D.; Jones, H. F. (Imperial Coll., London). Phys. Rev., 173: 1734-44(Sept. 25, 1968).

A systematic treatment is given of high-spin M functions in the Dirac-Rarita-Schwinger formalism. The main difficulty in writing such M functions is that apparently independent covariants are in fact related. These relations are derived (equivalence theorems) and it is shown how they may be used to obtain a kinematic-singularity-free expansion of the M function. Many examples are given and the general pattern is discussed. The restrictions due to discrete symmetries are also analyzed and it is shown how to choose invariant amplitudes whose discontinuities are given by unitarity. The connection with the helicity formalism is stressed throughout. (auth)

50477 REGGE BEHAVIOR AND THE CERULUS–MARTIN LOWER BOUND OF HIGH-ENERGY SCATTERING. Sawada, Tetsuo (Univ. of Colorado, Boulder). Phys. Rev., 173: 1716-19(Sept. 25, 1968).

From the Regge hypothesis for the high-energy scattering amplitude and the unitarity condition in the s channel, the functional equations for the Regge parameters $\alpha(t)$ and $\beta(t)$ are obtained. By examining these equations, the lower bound due to Cerulus and Martin for the high-energy scattering amplitude is derived. An additional assumption, that the scattering amplitude does not increase exponentially as s goes to infinity for fixed $\cos\theta$, enables us to show that the high-energy behavior of the scattering amplitude for fixed $\cos\theta$ is something between $\exp[-a_1(\cos\theta)(\sqrt{s})\ln(s/s_0)]$ and $\exp[-a_2(\cos\theta)\sqrt{s}]$. The possibility of the appearance of narrow dips in the high-energy scattering at relatively large momentum transfer is also pointed out. (auth)

50478 UNITARITY AND THE MANDELSTAM REPRESENTATION. II. LARGE-ANGULAR-MOMENTUM PARTIAL-WAVE AMPLITUDES. Martin, Arthur W. (State Univ., New Brunswick, N. J.). Phys. Rev., 173: 1439-51(Sept. 25, 1968).

The general assumption that the scattering amplitude satisfies an n-times-subtracted Mandelstam representation is shown to lead to precise predictions for large-angular-momentum partial-wave amplitudes. The real parts of the amplitudes are determined in the elastic and part of the inelastic regions. The imaginary parts are determined throughout the physical region. The calculations utilize the Legendre expansion of the crossed-channel absorptive parts, a rigorous expansion of the double spectral function in the neighborhood of its boundary, the elastic unitarity condition, and crossing symmetry. (auth)

Particle Accelerators

Refer also to abstracts 49161, 49355, and 50560.

50479 (BNL–12791) A PRELIMINARY STUDY OF THE TS ZERO MODE AND ITS ROLE IN FIELD FLATTENING OF MULTI AND TUNABLE STEM ACCELERATING STRUCTURES. Giordano, S.; Hannwacker, J. (Brookhaven National Lab., Upton, N. Y.). [1967]. 14p. (CONF-680515–25). Dep. CFSTI.

From Conference on Proton Linear Accelerators, Upton, N. Y.

Multistem and alternating tunable stem accelerating structures are studied. A comparison between the dispersion curves for multistem and alternating tunable stems at 30 MeV and 84 MeV is presented. Also, tank stability with a fixed frequency detuning perturbation is studied for both structures. Characteristics of the TS_{100} mode are described, and use of the TS_{100} mode to compensate for perturbations when operating in the TM_{010} mode is discussed. (W.H.K.)

50480 (BNL–12792) DESIGN OF A BUNCHER AND THE TRANSPORT SYSTEM IN ITS DRIFT SPACE FOR THE 200-MeV BNL INJECTOR LINAC. Agritellis, C.; Chasman, R. (Brookhaven National Lab., Upton, N. Y.). [nd]. 25p. (CONF-680515–28). Dep. CFSTI.

From Conference on Proton Linear Accelerators, Upton, N. Y.

Numerical buncher calculations taking into account the effects of space charge suggest the following conclusions regarding beam bunching for injection into the new 200 MeV Brookhaven linac. Beams of currents up to 400 mA can be bunched into the longitudinal acceptance of the linac with an efficiency of 50–60% by the use of a single buncher whose drift space is 70–80 cm. Maximum bunching efficiency can be obtained for a particular current by slight adjustment of the buncher voltage. For 50 mA several double buncher designs were found which can bunch the beam into a phase spread of +20° with an efficiency of 60%. It is possible to match the beam transversely at the input of the linac by the use of a quadrupole triplet in the buncher-linac drift space. For a particular buncher design considered in this paper the required magnetic field gradients in the quadrupoles were found to vary from 0.6 to 1.8 kG/cm for corresponding beam currents between 50 and 400 mA. (auth)

50481 (BNL–12793) NUMERICAL CALCULATIONS OF THE EFFECTS OF SPACE CHARGE ON SIX DIMENSIONAL BEAM DYNAMICS IN PROTON LINEAR ACCELERATORS. Chasman, R. (Brookhaven National Lab., Upton, N. Y.). [1968]. 20p. (CONF-680515–27). Dep. CFSTI.

From Conference on Proton Linear Accelerators, Upton, N. Y.

Six dimensional linac orbit calculations, performed with a computer program which was designed to include space charge forces in a perfect linac, give a simple reliable prescription to match the beam to both the longitudinal and transverse admittances of the linac. The resultant beam envelope oscillations remain quite small during the acceleration. Matched beams with currents up to several hundred milliamperes can be accelerated through the linac using measured characteristics of recently developed preinjectors and high initial quadrupole gradients. There is considerable transverse emittance growth in beams with a brightness of 10^9 and higher. This appears to be caused by non-linear space charge forces. (auth)

50482 (BNL–12794) FIELD MEASUREMENTS OF VARIABLE β MULTI-STEM ACCELERATING STRUCTURE. Giordano, S.; Hannwacker, J. (Brookhaven National Lab., Upton, N. Y.). [1967]. 10p. (CONF-680515-26). Dep. CFSTI.

From Conference on Proton Linear Accelerators, Upton, N. Y.

The axial electric field distributions of a single stem and a multistem drift tube support for a variable β cavity were measured and evaluated. It is seen that multistems can substantially reduce the electric field distortions introduced by both the change in β and those caused by detuning perturbations. (W.H.K.)

50483 (BNL–12801) THE BROOKHAVEN 200-MeV LINAC INJECTOR CONSTRUCTION PROGRESS REPORT. Grand, P.; (and others) (Brookhaven National Lab., Upton, N. Y.). [1967]. 17p. (CONF-680515–24). Dep. CFSTI.

From Conference on Proton Linear Accelerators, Upton, N. Y.

Some of the highlights of the present status of the construction of the new 200-MeV linac injector for the Brookhaven AG Synchrotron are presented. Building construction, Cockcroft–Walton preinjector, accelerating structure, and the rf system are discussed. (W.H.K.)

50484 (BNL–12830) SUPERCONDUCTING FFAG ACCELERATORS. Parzen, G. (Brookhaven National Lab., Upton, N. Y.). [1966]. 9p. (CONF-680621–8). Dep. CFSTI.

From Conference on Superconducting Devices and Accelerators, Upton, N. Y.

The feasibility of building a fixed field alternating gradient (FFAG) accelerator using a superconducting high field magnet is discussed. Some parameters for such an accelerator are estimated and it is suggested that the FFAG should be a multistage accelerator. (J.W.R.)

50485 (BNL–12831) SUMMARY OF SIXTH WEEK OF 1968 SUMMER STUDY. Blewett, J. P. (Brookhaven National Lab., Upton, N. Y.). [nd]. 6p. (CONF-680621–6). Dep. CFSTI.

From Conference on Superconducting Devices and Accelerators, Upton, N. Y.

The proceedings of the sixth week of 1968 summer study at Brookhaven are described. The topics discussed included superconducting synchrotrons, the FFAG, energy storage in superconducting magnets, and radiation effects on superconducting magnets. (J.W.R.)

50486 (BNL-12832) USE OF SUPERCONDUCTORS IN HIGH ENERGY PHYSICS. Blewett, J. P. (Brookhaven National Lab., Upton, N. Y.). [1967]. 7p. (CONF-680621-5). Dep. CFSTI.

From Conference on Superconducting Devices and Accelerators, Upton, N. Y.

Possible uses of superconductors in high energy physics, including beam transport magnets, magnets for bubble chambers, spark chambers, and spectrometers are described. (J.W.R.)

50487 (CONF-680411) PROCEEDINGS OF THE CONFERENCE ON THE USE OF SMALL ACCELERATORS FOR TEACHING AND RESEARCH HELD AT THE OAK RIDGE ASSOCIATED UNIVERSITIES, OAK RIDGE, TENNESSEE, APRIL 8-10, 1968. Duggan, Jerome L. (ed.) (Oak Ridge Associated Universities, Inc., Tenn.). 471p. Dep. CFSTI.

Twenty-three papers are presented on topics including neutron activation analysis, health physics problems with small accelerators, educational uses of small accelerators, low energy nuclear physics experiments, and survey papers. Small accelerators refer to Cockcroft-Walton or Van de Graaff machines with accelerating potentials which are less than 0.5 MeV. (auth)

50488 (LA-3903) GENERAL PURPOSE COMPUTER CODE FOR PARTICLE TRAJECTORIES AND OTHER PROBLEMS. Lewis, H. R. Jr. (Los Alamos Scientific Lab., N. Mex.). Mar. 1968. Contract W-7405-eng-36. 20p. Dep. CFSTI.

Instructions for using a computer code for computing and graphing the solutions of a general system of not more than six first-order differential equations are presented with an example. The user is allowed very flexible control of the type and format of graphical output by means of data cards. A listing of the code is given in FORTRAN for the CDC 6600. (auth)

50489 (MPS/Int.DL/B-67-19) THE SECOND STAGE CPS IMPROVEMENT STUDY. 800 MeV BOOSTER SYNCHROTRON. (European Organization for Nuclear Research, Geneva (Switzerland)). Oct. 3, 1967. 239p. Dep.

Improvements proposed for the Cern Proton Synchrotron (CPS) in order to increase the protons accelerated per cycle are described. Proposed improvements were the construction of an 800 MeV booster synchrotron between the 50 MeV linac and the CPS as well as modifications on the linac and the CPS. The research program for the CPS is outlined. (J.W.R.)

50490 (NP-17574) CHARGE VARIATIONS DURING THE INJECTION AND EXTRACTION PROCESSES AND PARTICLE ACCELERATION. Taut, T.; Fiks, M. M. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Reactions). Feb. 1968. 56p. (In Russian). Dep.

Examples examined show that charge variation of particles reveals new possibilities for accelerator technology. The use of ion charge in the acceleration process was used in an installation of the tandem-generator type and in linear accelerators. With the help of overcharging, a proton beam can be extracted from the cyclotron and also the problems of the tapping of heavy ions from the cyclotron chamber with azimuthal variation of the magnetic field and capture of energetic particles in cyclic accelerators were solved relatively easily. In some cases the use of overcharged particles, makes it possible to expand the number of contemporary types of accelerators with new installations. The examples studied included the effects of overcharging during passage of ions through matter, use of charge variation in contemporary accelerators, and particle accelerators with variable charge in potential electric field. (tr-auth)

50491 (NP-17628) EUROPEAN ORGANIZATION FOR NUCLEAR RESEARCH ANNUAL REPORT, 1967. (European Organization for Nuclear Research, Geneva (Switzerland)). 183p. Dep.

Developments at CERN in 1967 are outlined. Research and development in nuclear physics, the synchrocyclotron, bubble chambers, theoretical high-energy physics, the proton synchrotron, data handling, and the Intersecting Storage Rings are discussed. Also finance, personnel, and technical services and buildings are reviewed. (W.H.K.)

50492 (SLAC-PUB-469) RADIATION EFFECTS ON SUPERCONDUCTING MAGNETS. Brechna, H. (Stanford Linear Accelerator Center, Calif.). Aug. 1968. 54p. (CONF-680621-11). Dep. CFSTI.

From Conference on Superconducting Devices and Accelerators, Upton, N. Y.

Based on simplified models and approximations, induced radioactivity in superconducting coils due to high-energy particles is calculated. The effects of irradiation on a few commercially available superconductors of Type II are presented. Physical and mechanical changes of metals, insulations, and helium due to nuclear irradiation are discussed.

50493 (UCRL-18186) ECONOMIC FACTORS INVOLVED IN THE DESIGN OF A PROTON SYNCHROTRON OR STORAGE RING WITH A SUPERCONDUCTING GUIDE FIELD. Green, Michael A. (California Univ., Berkeley. Lawrence Radiation Lab.). July 31, 1968. Contract W-7405-eng-48. 29p. Dep. CFSTI.

The most important economic considerations involved in the design of a superconducting synchrotron are discussed. The cost of all the important accelerator components is estimated for a number of types of accelerators. The effect of the important machine parameters on machine cost is discussed. The important physical and economic differences between superconducting and conventional synchrotrons are presented. The effect of these differences on the design of machine is investigated. The importance of the ac loss is discussed. In conclusion, this report shows that a number of the machine parameters should be determined by economic factors rather than by fiat. (auth)

50494 (UCRL-18259) BEVATRON OPERATION AND DEVELOPMENT. 57, JANUARY-MARCH 1968. Crebbin, Kenneth C.; Frias, Robert (California Univ., Berkeley. Lawrence Radiation Lab.). Aug. 5, 1968. Contract W-7405-eng-48. 14p. Dep. CFSTI.

The beam was on for 86.9% of the scheduled operating time and the Bevatron accelerated 2.32×10^{18} protons this quarter. One internal-beam experiment was finished this quarter and setup of a new experiment in its place was begun. Setup work continued on the new dual-channel external proton beam channel. Preliminary tests were started on the beam channel to the 25-inch bubble chamber. There was a one-week shutdown in February. This is the first of several shutdowns planned in order to effect a reduced level in operation and in experimental physics, as dictated by cutbacks in the high energy physics budget. Work was continued on the resonant extraction system. A new flattop mode of magnet pulsing was tried which is designed to reduce the stresses on the motor generator poles. (auth)

50495 THE ION-OPTICAL PROPERTIES OF MAGNETIC PRISMS WITH r^{-1} FIELD FOR FOCUSING BEAMS OF CHARGED PARTICLES WITH WIDE ANGULAR DIVERGENCE. Fedoseev, E. P. (Kurchatov Inst. of Atomic Energy, Moscow). Kernenergie, 11: 191-7(July 1968). (In Russian).

The ion-optical properties of focusing magnetic prisms, the field of which varies according to $Hr = H_0 r_0$ in the median plane (r^{-1} field), are studied in detail. Broad, extended beams are considered, of which the total angle of divergence in the median plane is up to 25-30°. Formulas are derived for the chromatic and angular aberrations as well as the aberrations due to the geometry of the source. The image line shape and angle of inclination of the focal line towards the axis of the particle beam with resonance momentum are determined by studies in the paraxial region allowing also to determine the optimum conditions of focusing under which the image line is a straight line and has uniform density. It is shown that many modifications exist which make possible stigmatic focusing of the second order for convergent beams. The stability of the systems under consideration to longitudinal fluctuations of the cross-over in the source and to inaccuracies of the radial field distribution is investigated. From the results of the work one may conclude that magnetic prisms with r^{-1} field having interesting ion-optical properties may be designed in various modifications which may be used in mass-spectrometry and mass separation as well as for the construction of instruments in nuclear spectroscopy. (auth)

50496 A FIRST- AND SECOND-ORDER MATRIX THEORY FOR THE DESIGN OF BEAM TRANSPORT SYSTEMS AND CHARGED PARTICLE SPECTROMETERS. Brown, Karl L. (Stanford Univ., Calif). pp 71-134 of Advances in Particle Physics. Vol. I. Cool, R. L. (ed). New York, John Wiley and Sons, Inc., 1968.

A matrix algebra formalism is used to develop the essential principles governing the design of charged-particle beam transport systems, with particular emphasis on the design of high-energy magnetic spectrometers. In particular to the first order, the momentum dispersion, the momentum resolution, the particle path length, and the necessary and sufficient conditions for zero dispersion, achromaticity, and isochronicity are expressed as simple integrals of particular first-order trajectories (matrix elements) characterizing a system. Some information on the mechanism of second-order aberrations also results from the

formalism; for example, the effects of magnetic symmetry on the minimization or elimination of second-order aberrations. Physical examples are given to illustrate the applicability of the formalism to the design of specific spectrometers. (L.B.S.)

50497 ONE-THIRD RESONANCE EXTRACTION FROM INS AG ELECTRON SYNCHROTRON. Huke, Kazuo (Tokyo Univ.); Kobayashi, Yoshiyuki; Yamakawa, Tatsuya; Yamaguchi, Seitaro; Yamashita, Sukeaki. Jap. J. Appl. Phys., 7: 1274-86(Oct. 1968).

Slow beam extraction from the INS-AG electron synchrotron was done by using a one-third resonance of the betatron oscillation. A current strip was used to change the number of the radial betatron oscillation per revolution from 2.25 to 7/3 and to enlarge the amplitude of the oscillation. The extracting beam orbit was analyzed using an approximate Hamiltonian which has a separatrix represented by three straight lines and the result was in good agreement with that pursued by a computer. The properties of the extracted beam are given. The efficiency was 50% for electrons of 300 MeV up to 1 GeV. The maximum beam intensity was 4×10^{11} electrons per second. The maximum duty cycle was 3%. Phase volumes for the horizontal and the vertical motions were 10^{-6} rad cm and 0.75×10^{-6} rad cm, respectively. The beam transport system and the radiation shielding system are also described. (auth)

50498 ION FOCUSING PROPERTIES OF A DOUBLE MAGNETIC QUADRUPOLE LENS PAIR. Freindl, Ludwik (Inst. of Nuclear Physics, Krakow); Karcz, Waldemar. Nukleonika, 13: 859-70(1968).

A double magnetic quadrupole lens pair set used for focusing nuclear particles from nuclear reactions is described. Experimental parameters of the lenses are compared with theoretical ones. The application of a quadrupole lens pair set in polarization measurements is discussed. (auth)

50499 COMPARISON BETWEEN THE 30-MeV FLUX-FORCED FIELD-BIASED BETATRON AND THE 35-MeV CONVENTIONAL BETATRON. Tanaka, Osamu; Takukura, Koichi (Mitsubishi Electric Corp., Japan). Mitsubishi Denki Lab. Rep., 8: 105-24(Apr. 1967).

A 30 MeV flux-forced, field-biased betatron has been constructed for the purpose of research. It has been accelerated to an energy of 29 MeV by adding a dc magnetic field up to phase-angles of 45°. The maximum x-ray output obtained to date is 15 R/min at 1 meter from the target with the energy of 20 MeV as measured by a thin walled ionization chamber. A 35 MeV conventional betatron has been constructed for radiology or radiography. The maximum energy attained is 34 MeV and x-ray output available is 90 R/min at 1 meter from the target with the energy of 30 MeV. This paper deals with comparison of the structures, performance, features and electronic orbits between them. (auth)

50500 THE 10-GeV SYNCHROTRON AT CORNELL. McDaniel, Boyce D.; Silverman, Albert (Cornell Univ., New York). Phys. Today, 21: No. 10, 29-38(Oct. 1968).

The design and operation of the 10-GeV electron synchrotron at Cornell is described. The experimental program for which the synchrotron will be used is discussed. (J.W.R.)

50501 SPACE CHARGE AND VERTICAL MOTION NEAR THE CENTRE OF THE CYCLOTRON. Lawson, J. D. (Rutherford Lab., Chilton, Eng.). Nucl. Instrum. Methods, 64: 214-16 (Sept. 15, 1968).

The vertical motion of ions near the center of the cyclotron is calculated using a simple model which takes into account space charge, and both magnetic and electric focusing forces. (auth)

50502 RADIATION SHIELDING FOR HIGH ENERGY MUONS: THE CASE OF A CYLINDRICALLY SYMMETRICAL SHIELD AND NO MAGNETIC FIELDS. Keefe, D.; Noble, C. M. (Univ. of California, Berkeley). Contract W-7405-eng-48. Nucl. Instrum. Methods, 64: 173-80(Sept. 15, 1968).

At proton accelerators with energies of tens of GeV and more, the shielding problems are dominated by the requirement of reducing the flux of muons to tolerable levels. This is especially true for accelerators making extensive use of extracted proton beams. We present a technique for calculating the profile of the radiation shield for muons for a number of practical situations of interest, viz., beam loss in an internal target area, beam loss during transport of the extracted beam down a long narrow pipe, and the case in which the extracted proton beam is dumped in a backstop. Results obtained from a computer program are presented graphically for different possible shield materials—heavy concrete, iron, lead, and depleted uranium. The results span four orders of magnitude in muon flux normalized to the rate of interacting protons, so that one can obtain useful results by interpolation for a wide variety of beam loss and desired shielding situations. The primary proton energies used in the calculations—25, 70, 200 and 300 GeV—correspond to the energies of proton accelerators at present either operating or under design. (auth)

50503 ION BEAM GENERATOR HAVING LASER-ACTIVATED ION SOURCE. Swain, James E.; Truher, John B. (to United States Atomic Energy Commission). U. S. Patent 3,406,349. Oct. 15, 1968.

An ion source and accelerator for producing ion beams of energies up to several MeV and up to hundreds of amperes is described. It consists of a target of a material to be ionized disposed in the light beam path of a laser, means for concentrating the light beam to impinge the target surface with an energy sufficient to ionize the target material and produce a plasma, electrode means for extracting the desired ions from the plasma produced by the light beam impinging on the target, and electrostatic accelerator means for producing an electric field to accelerate the ions. (AEC)

50504 ELEKTRONNYE USTROISTVA NA ELEKTROSTATICHESKIKH USKORITELYAKH. (Electronic Devices Operated with Electrostatic Accelerators). Brovchenko, V. G.; Vorotnikov, P. E.; Molchanov, Yu. D. Moscow, Atomizdat, 1968. 336p.

A brief review is given on electronic methods and electronic devices used with electrostatic accelerators including the theory of low-noise amplifiers, semiconductors, and other ionization particle detectors, protection means from external electrical interferences, and instruments for determining high-voltage intensity. The first, second and third chapters cover the various charge systems, ion sources, and production of short pulses for the current beam. The fourth chapter deals with the measurement of charged particle energies and acceleration intensity. The fifth and sixth chapters include data on stabilization of acceleration and magnetic fields. The measurement of space and time parameters of charged-particle beam currents are discussed in the seventh chapter. The protection from external field interference and low-noise pulse amplifiers are covered in the eighth and ninth chapters. 251 references are included. (R.V.J.)

50505 BEAM VACANCIES AS TIMING MARKERS FOR HIGH-CURRENT ACCELERATORS. Benenson, R. E. (State Univ. of New York, Albany). Nucl. Instrum. Methods, 64: 226-8(Sept. 15, 1968).

A method for continuous time-of-flight energy calibrations of high current accelerator beams is proposed. Pulses induced by momentary beam vacancies have been detected successfully. (auth)

50506 GENERAL PURPOSE INVERTED SCATTERING CHAMBER PARTICULARLY SUITED FOR ANGULAR CORRELATION WORK. Plattner, R.; Anderson, J.; Ritter, R.; Schier, W. A.; Stone, J. (Univ. of Virginia, Charlottesville). Nucl. Instrum. Methods, 64: 192-6(Sept. 15, 1968).

A versatile scattering chamber of unconventional design has been built for charged-particle work and for correlation experiments involving detectors within and outside the chamber. The inverted chamber is cantilever-supported with a free space of about 1.7 m radius beneath it for positioning bulky shielding and detector carriages. The concept is to have a precision base which houses electrical feedthroughs, accurately positionable arms for detectors and targets, and a high-speed pumping port. Chamber lids are considered to be simple accessories which are fabricated to the needs of particular experiments. Simplicity and economy are stressed throughout the design. (auth)

50507 X-RADIATION FROM POSITIVE ION BEAMS INCIDENT ON INSULATOR TARGETS. Weiss, M. M. (Bell Telephone Labs., Inc., Murray Hill, N. J.). Health Phys., 15: 372 (Oct, 1968).

It was noted that several positive ion accelerators operating in the energy range of 100 keV and lower were producing significant x-ray intensities in the vicinity of the target, and it was determined that this radiation was present only when the target material was a good insulator. To examine this, further investigations were made using a positive ion accelerator operating in the 40 to 70 keV range and accelerating nitrogen ions. High radiation levels were detected directly above the drift tube on the beam side of the quartz target. It is believed that the radiation may be caused by field emission electrons from the drift tube walls, these electrons being accelerated to the positively charged target and there producing x rays. The radiation can be eliminated by avoiding the use of insulator targets or by placing a conducting grounded coating on the beam side of the target. (UK)

50508 COMPUTATION OF THE EFFECTIVE SOLID ANGLE IN ANGULAR CORRELATION EXPERIMENTS USING GAS TARGETS. Bar-Avraham, E.; Lee, L. C. (Univ. of Southern California, Los Angeles). Contract AT(04-3)-136. Nucl. Instrum. Methods, 64: 141-7(Sept. 15, 1968). (USC-136-137).

A simple method is presented to calculate the effective solid angle for a correlation experiment using a gas target. This method permits us also to calculate the angular spread for each angle setting. A computer program using this method is presented. (auth)

50509 HIGH-FLUX NEUTRON GENERATOR. Romanenko, V. M.; Sit'ko, S. P.; Strizhak, V. I. (Kiev State Univ.). Ukr. Fiz. Zh., 12: 1573-6(1967). (In Russian).

The design of a high-current ion source with a stable ion current over a prolonged period of time is described. The ion beam is focused by an electron-optical system of lens, and accelerated down a tube (12 sections) 36 cm long. The ion beam can be focused on the target with a diameter from 5.6 to 9.2 mm. Details of construction are presented. Targets of Cu, Ag, Au, and Zr can be used to obtain neutron fluxes of 10^8 to 10^9 neutrons/sec over a prolonged period of time by a D(d,n) reaction. Fluxes of 10^{10} to 10^{11} neutrons/sec are possible by a T(d,n) reaction. The highest neutron yield was obtained by using a gold target (about 5×10^8 neutrons/sec from a D(d,n) reaction at a 4 ma current and a 140 kv voltage). (TTT)

PHYSICS (NUCLEAR)

Neutron Interactions with Matter

Refer also to abstracts 49101, 50509, 50559, 50598, 50599, and 50657.

50510 INFLUENCE OF ANISOTROPY OF ELASTIC SCATTERING ON THE PROPAGATION OF THE FAST FLUX NEAR THE SHIELD. Adamoli, Francesco; Brusa, Luisa (AGIP Nucleare, Milan. CNEN, Rome). pp 759-72 of Fisica del Reattore. Rome, Consiglio Nazionale delle Ricerche, 1966. (In Italian).

From Conference on Physics of Reactors, Milan. See CONF-469.

The neutron transport equations, assuming isotropic inelastic scattering in a homogeneous medium, are solved in terms of neutron flux. The probability of elastic scattering is determined. Fast and thermal neutron fluxes are then calculated for plane and point sources and a fission spectrum; calculated results are compared with experimental values to obtain flux correction values for shielding calculations. (M.L.S.)

50511 SEVERAL OBSERVATIONS ON THE TRANSPORT EQUATION. Cercignani, Carlo (Applicazioni e Ricerche Scientifiche, Milan). pp 633-42 of Fisica del Reattore. Rome, Consiglio Nazionale delle Ricerche, 1966. (In Italian).

From Conference on Physics of Reactors, Milan. See CONF-469.

A correlation of the Case method for solution of the monokinetic transport equations and the method introduced by Chandrasekhar in the theory of radiative transfer is obtained. An expression for the angular distribution of emergent radiation in the half-plane is derived. These expressions are applied to the invariant imbedding equations for homogeneous half-space. Integrodifferential operator techniques are applied to the time-dependent transport equations; eigenvalues are obtained for the equations. Results are compared with results from a variational equivalence principle. 9 references. (M.L.S.)

50512 METHOD OF THE SUPERFICIAL SOURCE. Montagnini, Bruno; Pierpaoli, Valeria (AGIP Nucleare, Milan). pp 643-58 of Fisica del Reattore. Rome, Consiglio Nazionale delle Ricerche, 1966. (In Italian).

From Conference on Physics of Reactors, Milan. See CONF-469.

A formulation of the one-velocity transport equation is given. The Greens function is determined for isotropic scattering in an infinite homogeneous medium; this Greens function is then formulated as a source term for the transport equations. The extension of the one-velocity equations into two-velocity form is outlined. As an example, the equations are applied to the Milne problem. (M.L.S.)

50513 SEVERAL ASPECTS OF THE SLOWING DOWN EQUATION. Gallone, Sergio; Ghilardotti, Giancarlo (AGIP Nucleare, Milan. Univ., Milan). pp 659-66 of Fisica del Reattore. Rome, Consiglio Nazionale delle Ricerche, 1966. (In Italian).

From Conference on Physics of Reactors, Milan. See CONF-469.

An analytic expression for angular slowing density is derived and is introduced into the transport equation. The Legendre components are determined; the Legendre collision integral is developed. An expression for slowing down area for age theory is determined; corrective terms for age are tabulated. (M.L.S.)

50514 GENERAL THEORY OF NEUTRON MODERATION. Boffi, Vinicio C.; Molinari, Vincenzo G.; Scozzafava, Romano (CNEN, Rome). pp 667-83 of Fisica del Reattore. Rome, Consiglio Nazionale delle Ricerche, 1966. (In Italian).

From Conference on Physics of Reactors, Milan. See CONF-469.

Solutions to the time- and energy-dependent neutron transport equations for an infinite homogeneous medium are given. An asymptotic solution to the equations is developed using Laplace transform techniques; an exact solution is obtained in terms of an infinite series. The asymptotic and exact solutions are compared; behavior under both stationary and time-energy-variation conditions is considered. (M.L.S.)

50515 TIME-DEPENDENT NEUTRON TRANSPORT EQUATION. Corno, Silvio (Univ., Pavia, Italy. AGIP Nucleare, Milan). pp 589-602 of Fisica del Reattore. Rome, Consiglio Nazionale delle Ricerche, 1966.

From Conference on Physics of Reactors, Milan. See CONF-469.

An investigation of the possibility of simplifying time-dependent transport theory for problems involving time-dependent external sources and time-dependent boundary conditions is outlined. It is proved that any neutron distribution which can be sustained in a given multiplying medium by means of time-dependent volume or surface sources can be completely determined as soon as the transient response of the system to sources with time behavior of the step-function type is known. (D.C.W.)

50516 STUDY OF THERMALIZATION USING THE PULSED SOURCE METHOD. Accinni, Filippo; Palazzi, Fulvio; Zorzoli, Giovanni Battista (CISE, Milan). pp 509-17 of Fisica del Reattore. Rome, Consiglio Nazionale delle Ricerche, 1966. (In Italian).

From Conference on Physics of Reactors, Milan. See CONF-469.

Neutron thermalization studies using the pulsed source method are discussed. Schematics and block diagrams show the experimental apparatus. The 150-kV linear accelerator, used as a neutron source, and the pulsing circuit are described. Preliminary experimental data are given; decay constants and neutron temperature are shown, graphically, as a function of buckling. (M.L.S.)

50517 SLOWING DOWN OF NEUTRONS IN A CYLINDRICAL BOUNDED MEDIUM. Kozachok, I. A.; Kulik, V. V. (Inst. of Geophysics, Kiev). Ukr. Fiz. Zh., 13: 1086-92(July 1968). (In Russian).

The distribution of neutrons from a point source in a homogeneous isotropic medium bounded by a cylindrical surface is studied. The problem of slowing down of the neutrons is formulated by means of a partial differential equation which, unlike the age equation, is true for hydrogenous media. An analytical expression is found for neutron collision density in the medium as a function of the cylinder radius. (auth)

50518 DISTRIBUTION IN ENERGY AND ANGLE OF HIGH-ENERGY NEUTRONS FROM A GUN SOURCE. O'Brien, K.; McLaughlin, J. E. (Health and Safety Lab., New York). Nucl. Instrum. Methods, 64: 167-70(Sept. 15, 1968).

The distribution in angle and energy of neutrons emerging from an iron slab bombarded by the collimated 49° neutron beam of the Princeton-Pennsylvania Accelerator (PPA) has been measured and compared with an approximate 2-dimensional semianalytic solution to the neutron transport equation. Measurements were made using a proton spark chamber and a polyethylene radiator at 0°, 15°, 30° and 45° from the direction of the incident PPA neutron beam. The comparison extended from 4 to about MeV. Agreement was reasonably good and it is suggested that this kind of solution to the transport equation would be useful for the calculation of neutron fluxes from anisotropic point sources such as a shielded synchrotron target. (auth)

50519 LOW-ENERGY NEUTRON PHYSICS. Gurevich, I. I.; Tarasov, L. V. New York, John Wiley and Sons, Inc., 1968. 620p.

Translated by Scripta Technica Ltd., London.

A sufficiently physical, but rigorous, account of the nature and properties of the interaction between low-energy (<1 eV) neutrons and various media is presented; and the applications of low-energy neutrons in physical studies are reviewed. (D.C.W.)

50520 A DISCRETE STOCHASTIC MODEL FOR NEUTRON MODERATION AND REGENERATION. Williamson, Theodore Joseph. Seattle, Univ. of Washington, 1967. 180p.

Thesis.

A general model is developed for numerical calculations of neutron slowing-down parameters and functions in simple, homogeneous systems. The model assumes that slowing down can be represented as a discrete time, discrete state Markov process. Within the context of this approximation, Markovian transition probabilities and state expectations are derived from functions which describe the distributions in energy of neutrons which have suffered n scattering collisions in the state. The model is generally simple in application and requires less computation time than alternate methods such as Monte Carlo. It provides, on a fine time-energy mesh, a discrete representation of the neutron density, N(E,t) that evolves from a source that is a δ-function in time. The results are free of the statistical variations inherent in Monte Carlo methods. The efficacy of the model is demonstrated on several problems in simple moderators for which analytical solutions exist. Certain practical problems in simple moderators are examined and the model is shown to provide better results than other approximate analytical solutions or Monte Carlo methods. Temporal processes derivable from the time-energy distribution of a burst of neutrons slowing down are

examined in detail with the model for five bare, fast reactors. The Chapman–Kolmogorov equation is applied to extend the model to a multidimensional description but it is shown that calculations in such systems are generally impractical. A two space-state model for a spherical, reflected, fast reactor is described; and the results of a test calculation are presented. (Disser. Abstr.)

50521 NEUTRON DIFFUSION PARAMETERS OF PERFLUORODIMETHYLCYCLOHEXANE USING A TWO-REGION PULSED-NEUTRON TECHNIQUE. Bisselle, Charles Anthony. Gainesville, Fla., Univ. of Florida, 1967. 147p.

Thesis.

A technique was developed for determining the previously unknown thermal-neutron diffusion parameters, Σ_a and D, of a moderating material, perfluorodimethylcyclohexane, of which there was an insufficient amount to perform the usual static and/or pulsed-neutron experiments. A two-region cylindrical system consisting of the material with unknown properties in the core region and a water reflector was pulsed with neutrons, and the subsequent time behavior of the neutron population was recorded as the decay curve. A piecewise-fit method was developed to analyze the slope of this curve and to find the fundamental decay constant. As the height of the system was changed, different decay constants were obtained and plotted against the axial buckling for the various systems. A piecewise-fit approach of analyzing successive portions of the decay curve was developed and proved to be a very useful analytical tool. The guesswork involved in picking the later end point of the usual channel-chopping technique was eliminated. Moreover, the plot of the piecewise-fit decay constant as a function of time was capable of revealing the effects of varying harmonic contamination, slowly decaying background, and imperfections in the corrections for resolving-time losses. Diffusion theory, in spite of its elementary nature, has been satisfactorily utilized to describe the behavior of thermal neutrons in a two-region moderating system. One-group two-region diffusion theory in the form of the AIM-6 code was used to compute the decay constants for systems having the same composition as the experimental samples. The procedure was as follows: (1) preliminary values of the unknown macroscopic parameters, Σ_a and D, of C_8F_{16} were obtained from the usual recipe-type formulae for compounds using microscopic cross sections, (2) a correction factor was obtained from the comparison of experimental and computed decay constants for a two-region system for which all the parameters were known and was applied to the cases involving the unknown parameters, and (3) the input parameters for C_8F_{16} were adjusted until the experimental and computed decay constants were equal for a given system. The experimentally determined thermal-neutron diffusion parameters for C_8F_{16} are D = 1.015 cm, $\Sigma_a = 90 \times 10^{-5}$ cm^{-1}, and, L = 33.58 cm. In view of the various experimental and statistical errors involved in finding these parameters, error limits of ±8 percent are ascribed to each of the above values. These values are in reasonable agreement with the values obtained from the recipe-type formulae. (Disser. Abstr.)

Nuclear Properties and Reactions, A≤ 5

Refer also to abstracts 49088, 49162, 49929, 50416, and 50675.

50522 (ORNL–4317-1) DATA SUMMARIES (NUCLEAR-STRUCTURE PHYSICS). Tabular and Graphical Summaries of Experimental Results Reported in Recent Issues of Selected Journals. Raman, S.; Miller, J. (Oak Ridge National Lab., Tenn.). Sept. 1968. Contract W-7405-eng-26. 208p. Dep. CFSTI.

Graphical and tabular summaries of the results of experimental studies of nuclear structure are presented. The information was taken from issues of the journals Nuclear Physics, Physical Review, Physical Review Letters, and Physics Letters for the period Jan. through March 1968. The abstracts from the journal articles are reproduced, together with the data. (J.W.R.)

50523 ELASTIC PHOTOPRODUCTION OF NEUTRAL PIONS FROM HELIUM. Jain, S. C. (Allahabad Univ., India). Z. Phys., 215: 356-8(1968).

Differential cross sections were calculated for the elastic photoproduction of neutral pions from ^{4}He under the impulse approximation. A modified Irving wave function was used to describe the ground state of ^{4}He, whose parameters are obtained from a variational calculation of the binding energy of ^{4}He using a central velocity–dependent potential. The results are in reasonable agreement with the recent experiments of Belousov et al. (auth)

50524 SEARCH FOR THE GROUND STATE OF ^{5}H BY MEANS OF THE REACTION ^{3}H(t,p). Young, P. G.; Stokes, Richard H.; Ohlsen, Gerald G. (Los Alamos Scientific Lab., N. Mex.). Phys. Rev., 173: 949-51(Sept. 20, 1968).

Proton spectra from the ^{3}H(t,p)^{5}H and ^{3}He(t,p)^{5}He reactions were measured with a triton bombarding energy of 22.25 MeV. Narrow T = 3/2 states in the A = 5 system were not observed in either reaction. However, in the ^{3}H(t,p) reaction broad peaks appeared in the proton spectra at energies consistent with a ^{5}H state 1.8 MeV above the t + 2n mass. The possibility that this peak can be attributed to the ground state of ^{5}H is discussed. (auth)

50525 STUDY OF THE ^{4}He(γ,p)^{3}H AND ^{4}He(γ,n)^{3}He REACTIONS. Gorbunov, A. N. (Lebedev Inst. of Physics, Moscow). Phys. Lett., 27B: 436-8(Sept. 2, 1968).

The cross sections and angular distributions for ^{4}He(γ,p)^{3}H and ^{4}He(γ,n)^{3}He have been measured. (auth)

50526 NEUTRON–NEUTRON SCATTERING LENGTH FROM A COMPARISON OF THE ^{2}H(p,n)2p AND ^{2}H(n,p)2n REACTIONS. Slobodrian, R. J.; Conzett, H. E.; Resmini, F. G. (Univ. of California, Berkeley). Phys. Lett., 27B: 405-8(Sept. 2, 1968).

A study of the reaction ^{2}H(p,n)2p is reported which resolves the discrepancy among the values of the $^1S_0$ n-n scattering length deduced from the reaction ^{2}H(n,p)2n. The value $a_n = -16.7^{+0.5}_{-0.6}$ fm is consistent with results from the ^{2}H(π^-,2n)γ and ^{3}H(d,^{3}He)2n reactions. (auth)

50527 THE RMS CHARGE RADII OF TRI-NUCLEONS AND THE BINDING ENERGY OF ^{3}H. Mathur, V. S.; Lagu, A. V. (Banaras Hindu Univ., Varanasi, India). Nucl. Phys., A118: 369-78(1968).

Calculations are made for the rms charge radii of ^{3}H and ^{3}He and for the binding energy of ^{3}H using Ohmura's hard-core wave function modified, according to Schiff's hypothesis, to contain a certain admixture of the mixed symmetric state S′ with the predominant S state. It is found that an S-S′ cross term increases the binding energy of ^{3}H by as much as 20% thereby giving a good agreement with the observed binding energy for ^{2}D (hard-core) radius) lying between 0.4 and 0.6 fm rather than 0.2 fm as indicated earlier by Ohmura. The values of the rms charge radii of ^{3}H and ^{3}He obtained from the present calculations also agree well with the experimental values for about the same value of D. The effect of S′ admixture on the Coulomb energy of ^{3}He also is calculated and is found to be considerably less than Okamoto's estimate. (auth)

50528 CROSS SECTION OF t(n,p)^{3}n REACTION. Nakamura, Hiroshi (Gakuin Univ., Tokyo). Nucl. Phys., A118: 17-24(1968).

A theoretical analysis of the cross section of a possible t(n,p)^{3}n reaction is presented. (auth)

50529 A MEASUREMENT OF THE CROSS SECTION AND POLARIZATION IN PROTON-DEUTERON ELASTIC SCATTERING AT 198 MeV. Adelberger, Rexford Earle. Rochester, N. Y., Univ. of Rochester, 1968. 115p.

Thesis.

A simultaneous measurement was made of the proton-deuteron elastic differential cross section and polarization at an incident energy of 198 ± 2 MeV over an angular range of 80 to 170° in the center-of-mass. The relative errors on the cross section were 3 to 4 percent and the polarization was measured to ±0.01. A liquid deuterium target was bombarded with a polarized proton beam and the mass of the scattered particles determined. An elastic event was identified by the detection of a deuteron. The mass determination was done using a two-dimensional energy, time-of-flight analysis of the scattered particles. A PDP-8 computer was used on line to do this analysis. The polarization was measured rotating the spin of the beam from the vertical plane to the horizontal plane with a solenoid magnet, and by detecting the particles that scattered up and down. By reversing the direction of the magnet field in the solenoid, the polarization of the beam could be flipped 180 degrees in the horizontal plane, providing a measurement of polarization in which alignment errors cancelled to first order. The cross section was normalized to the proton-proton elastic cross section by filling the target cup alternately with liquid deuterium and liquid hydrogen. The normalization was obtained to an accuracy of 3 to 4 percent. The polarization of the beam was measured by doing a double p-carbon scattering, resulting in a value of 0.940 ± 0.015. During the normalization of the cross section using proton-proton scattering, the proton-proton polarization was also remeasured. The proton-deuteron elastic cross section has a value of 0.6088 mb/ster at 170 degrees in the center-of-mass, reaches a minimum value of 0.0968 mb/ster at 115 degrees in the center-of-mass, and then rises to a value of 0.197 mb/ster at 80 degrees in the

center-of-mass. The polarization rises from a value of zero at 180 degrees in the center-of-mass to 0.204 at 150 degrees in the center-of-mass, crossing zero again at 124 degrees in the center-of-mass, reaching a negative minimum of −0.504 at 90 degrees in the center-of-mass. Fits to the data using the simple impulse approximation and a "pickup" process were made, showing well the need for a more sophisticated theory to describe the elastic cross section and polarization data. During the second good data run, an attempt was made to detect a "singlet deuteron," a final state interaction where the proton and neutron leave the target with two-body kinematics, but are not in a bound triplet state. At 92.5 degrees in the center-of-mass, the cross section for production of this "particle" was 9 to 15 percent of the elastic cross section; the polarization parameter for the reaction was -0.23 ± 0.10 as compared to -0.50 for elastic scattering. An attempt was also made to look for deuterons and heavier particles produced in p-carbon scattering. Copious numbers of deuterons and a few ^{3}H particles were seen. (Disser. Abstr.)

Nuclear Properties and Reactions, $6 \leq A \leq 19$

Refer also to abstracts 49088, 49138, 49162, 49406, 50522, 50596, and 50674.

50530 (NP–17610) THE MEASUREMENT OF THE ROOT-MEAN-SQUARE RADII OF THE NUCLEI ^{9}Be, ^{12}C, ^{27}Al BY THE MODEL-INDEPENDENT METHOD. Startsev, V. I. (Akademiya Nauk Ukrainskoi SSR, Kharkov. Fiziko-Tekhnicheskii Institut). 1966. 79p. (In Russian). Dep.

A method is outlined for the determination of the root-mean-square radii of charge distributions in nuclear matter. A model-independent formalism is used for the evaluation of data on elastic scattering of 50- to 70-MeV electrons by light nuclei. The Born approximation theory used for analyzing data from Cherenkov counters and nuclear photoemulsions is described. Values of the root-mean-square radii of ^{9}Be, ^{12}C, and ^{27}Al, determined by the model-independent method, are given. (R.V.J.)

50531 REACTION ^{14}N$(\alpha,\gamma)^{18}$F. Parker, P. D. (Yale Univ., New Haven. Brookhaven National Lab., Upton, N. Y.). Phys. Rev., 173: 1021-5(Sept. 20, 1968).

The reaction ^{14}N$(\alpha,\gamma)^{18}$F was studied over the range of bombarding energies from 1.00 to 1.70 MeV. In addition to the well-known resonances at 1.53 and 1.62 MeV, two new resonances were found at α-particle energies of 1.140 ± 0.005 MeV and 1.395 ± 0.005 MeV, corresponding to excited states in ^{18}F at energies of 5.290 and 5.490 MeV, respectively. The branching ratio for the γ decay of the 5.29-MeV state was determined as $5.290 \rightarrow 2.524$ [(87 ± 3)%] and $5.290 \rightarrow 0.937$ [(13 ± 3)%]. The quantity $(2J + 1)\Gamma_\gamma \Gamma_\alpha/\Gamma$ for the total electromagnetic decay of each of these four resonances was determined as 0.084 ± 0.004 eV (1.140 MeV), 0.027 ± 0.003 eV (1.395 MeV), 4.80 ± 0.40 eV (1.53 MeV), and 1.35 ± 0.15 eV (1.62 MeV), respectively. On the basis of the observed lack of nonresonant yield from the ^{14}N$(\alpha,\gamma)^{18}$F reaction in this energy region, it is possible to establish an upper limit on the nonresonant S factor for this reaction, $S \leq 1.5 \times 10^6$ keV b. (auth)

50532 GAMMA-RAY DECAY OF THE 6.92-, 7.12-, 8.88-, AND 13.10-MeV STATES IN ^{16}O. Wilkinson, D. H. (Brookhaven National Lab., Upton, N. Y.); Alburger, D. E.; Lowe, J. Phys. Rev., 173: 995-1001(Sept. 20, 1968).

The reactions ^{19}F$(p,\alpha)^{16}$O and ^{15}N$(p,\gamma)^{16}$O were used to study the γ-ray branching of ^{16}O states at 6.72, 7.12, 8.88, and 13.10 MeV. Measurements were made with two 5×6-in. and two 3×3-in. NaI(Tl) detectors in various coincidence combinations. Two-dimensional pulse-height analysis was employed in some cases. The γ-ray branches from the $J^\pi = 2^+$ 6.92- and 1^- 7.12-MeV states to the $J^\pi = 3^-$ 6.13-MeV level were found to be $\leq 8 \times 10^{-4}$ and $7.0 \pm 1.4 \times 10^{-4}$, respectively. For the $J^\pi = 2^-$ 8.88-Mev level, the branches to the 7.12-, 6.92-, 6.13-MeV, and ground states are 12.6 ± 2.0%, 4.2 ± 0.8%, 76.0 ± 3.0%, and 7.2 ± 0.8%, respectively. The E1 branch, $13.10 \rightarrow 6.06$ MeV, was observed to have an intensity of $5.8 \pm 1.2 \times 10^{-3}$, corresponding to a B(E1) of 0.037 relative to that of the E1 ground-state transition. The significance of the various results in the description of states in ^{16}O is discussed. (auth)

50533 ELASTIC AND INELASTIC SCATTERING OF ^{3}He BY ^{12}C, 12.0 to 18.0 MeV. Fortune, H. T.; Gray, T. J.; Trost, W.; Fletcher, N. R. (Florida State Univ., Tallahassee). Phys. Rev., 173: 1002-10(Sept. 20, 1968).

Yield curves for the elastic scattering of ^{3}He by ^{12}C were measured simultaneously at 17 angles over the bombarding energy range 12.0 to 18.6 MeV. Inelastic scattering yield curves were measured at selected angles for the same energy range. Detailed angular distributions for both elastic and inelastic scattering were measured at 16, 17, and 18 MeV. The elastic scattering was analyzed with the optical model. Results indicate that a surface absorptive potential is equivalent to a volume absorption with a much larger radius. Optical parameters used to produce a reasonable representation of the angular distributions at all three energies are: V = 165 MeV, W = 9.96 MeV, W′ = 0, V_{so} = 0, R_v = 2.9 F, R_w = 4.96 F, and $a_v = a_w$ = 0.80 F. (auth)

50534 POLARIZATION OF THE NEUTRONS FROM THE REACTION ^{12}C(d,n)^{13}N AT THE 4-MeV RESONANCE AND BETWEEN 5.2 AND 6.2 MeV. Donaghue, T. R.; Baker, W. L.; Beach, P. L.; DeMartini, D. C.; Soltesz, C. R. (Ohio State Univ., Columbus). Phys. Rev., 173: 952-7(Sept. 20, 1968).

Angular distributions of the polarization of the neutrons from the ^{12}C(d,n)^{13}N reaction were measured for the ground-state and first-excited-state transitions at six energies between 5.2 and 6.2 MeV. The characteristic shape of the polarization angular distribution for the ground-state neutrons that was previously observed to emerge at about 3.5 MeV persists in this energy region, indicating the predominance of a direct-reaction mechanism in producing the polarization. The measurements for the first-excited-state neutron group ($l_p = 0$ transfer) show polarizations with maximum values of +0.30 at the forward angles. The forward-angle data in the 4.6- to 5.8-MeV interval do not exhibit interference effects between compound-nucleus and direct-reaction processes. A careful investigation of the polarization on the isolated resonance at 4 MeV was also conducted. Interference effects between compound-nucleus formation and a direct-reaction mechanism are observable here even on the stripping peak. The resonance, however, does not appreciably distort the characteristic shape of the polarization arising from the direct-reaction process. (auth)

50535 MAGNETIC DIPOLE TRANSITIONS AND ISOSPIN IN ^{8}Be. Paul, P.; Kohler, D.; Snover, K. A. (Stanford Univ., Calif.). Phys. Rev., 173: 919-30(Sept. 20, 1968).

Gamma transitions to the pair of $J^\pi = 2^+$ states at 16.64 and 16.90 MeV in ^{8}Be were observed in the reaction ^{7}Li$(p,\gamma)^{8*}$Be $\rightarrow 2\alpha$. The transitions to both states are resonant at the 17.64- and 18.15-MeV states, which have $J^\pi = 1^+$. The following resonant cross sections and branching ratios were obtained: $\sigma(17.6 \rightarrow 16.6) = 11 \pm 2$ μb; $R(17.6 \rightarrow 16.90/17.6 \rightarrow 16.6) = (7 \pm 2)$%; $\sigma(18.2 \rightarrow 16.6) = 1.30 \pm 0.32$ μb; $R(18.2 \rightarrow 16.90/18.2 \rightarrow 16.6) = (50 \pm 10)$%. From these transitions and the reported strengths for the transitions from the $J^\pi = 1^+$ states to the ground and first excited states, the amount of isospin mixing in the four highly excited states was determined using intermediate-coupling shell-model wave functions. The squared T = 1 components amount to 40% and 60% in the 16.6- and 16.9-MeV states, and 95% and 5% in the 17.6- and 18.2-MeV states, respectively. Using these mixing coefficients and the assumption of pure T = 0 character for the ground and first excited states, a shell-model calculation accounts approximately for the strengths of most of the observed or reported magnetic dipole transitions from the 17.64- and 18.15-MeV states. Inclusion of a possible $J^\pi = 1^+$, T = 1 level at 19.4 MeV improves the agreement. A large nonresonant transition to the 16.6-MeV state with $\sigma \simeq 2$ μb can be ascribed to direct radiative proton capture which yields a reduced proton width of $\theta_p^2 = 0.7$ for the final state. This transition, and the fact that the equivalent transition to the 16.9-MeV state is not observed, substantiate the predominance of a (^{7}Li + p) configuration for the 16.6-MeV state and agree with an assumed (^{7}Be + n) configuration for the 16.9-MeV level. (auth)

50536 POLARIZATION IN ^{12}C(p,p)^{12}C. Terrell, G. E.; Jöhns, M. F.; Kostoff, M. R.; Bernstein, E. M. (Univ. of Texas, Austin). Phys. Rev., 173: 931-6(Sept. 20, 1968). (ORO–2972-60).

Five accurate absolute polarization values for elastic scattering of protons from carbon were measured in the energy region between 4.6 and 7.2 MeV. These results were used as the basis for polarization measurements on and near the scattering anomalies at 5.38, 5.88, and 9.13 MeV in ^{12}C(p,p)^{12}C. Differential cross sections were also measured at the same energies as the polarizations. (auth)

50537 ^{13}N LEVELS FROM ^{12}C(p,p)^{12}C. Bernstein, E. M.; Terrell, G. E. (Univ. of Texas, Austin). Phys. Rev., 173: 937-44(Sept. 20, 1968). (ORO–2972-59).

The polarization and differential cross-section data for ^{12}C(p,p)^{12}C on and near the anomalies at $E_p = 5.38$, 5.88, and 9.13 MeV, reported in the preceding paper, were analyzed to obtain level parameters for the corresponding states in ^{13}N. Assignments of $\frac{3}{2}^+$ and $\frac{5}{2}^-$, respectively, for the 5.38- and 5.88-MeV anomalies were verified. The doublet at 9.13 MeV

is assigned spins and parities of $^5/_2^-$ and $^7/_2^-$. Quantitative fits to excitation functions in the region of the doublet were obtained with the following values in the lab system for the resonant energy, total width, and elastic width for these states: $^5/_2^-$, 9.132 MeV, 33 keV, 8.6 keV; $^7/_2^-$, 9.132 MeV, 82 keV, 67 keV. It is found that although the two resonant energies may not be exactly equal, they probably do not differ by more than 2 keV. (auth)

50538 STUDIES OF PROTON SPIN FLIP IN INELASTIC SCATTERING FROM CARBON AND NICKEL ISOTOPES. Kolasinski, Wojciech Adam. Seattle, Univ. of Washington, 1967. 108p.

Thesis.

The probability for proton spin-flip was measured in the reactions $^{12}C(p,p')^{12*}C(4.43)$ at 12, 13, 14, and 15 MeV; $^{58}Ni(p,p')^{58*}Ni$ (1.45) at 9.25, 10.46, and 15.0 MeV; and in the reactions ^{60}Ni $(p,p')^{60*}Ni(1.33)$ and $^{64}Ni(p,p')^{64*}Ni(1.34)$ at 10.5 and 14 MeV. Use was made of the technique in which the inelastically scattered protons are detected in coincidence with deexcitation gamma-rays emitted along the direction perpendicular to the scattering plane. The transitions which were investigated are of the type $0^+-2^+-0^+$, and in these cases, gamma rays are emitted along the reaction-plane normal only if spin flip occurs. In ^{12}C the measured spin-flip probability exhibits an angular dependence characterized by a small peak in the neighborhood of 55°, ranging in magnitude between 0.1 and 0.2. A larger peak is observed at backward angles whose position changes with energy, and whose magnitude is ≈0.35. A similar pattern is observed in the nickel isotopes, except for the data obtained in ^{58}Ni at 9.25 and 10.46 MeV. The backward peak is observed in all cases in the neighborhood of 150°, and its magnitude ranges between ≈0.15 in ^{60}Ni and ^{64}Ni at 14 MeV, and ≈0.3 in ^{58}Ni at 15 MeV. In ^{64}Ni, the magnitude of the backward peak decreases from 0.28 at 10.5 MeV, to 0.15 at 14 MeV. In all cases, the forward peak is observed in the vicinity of 70°, and its magnitude is found to be ≈0.07. At the lower energies in ^{58}Ni, contributions from compound-nuclear processes are encountered. A theoretical analysis of the results has been carried out, using the collective extension of the optical model with a spin-orbit interaction. Agreement with the carbon data is very poor. In the case of the nickel isotopes, better agreement is obtained. The calculations show that in order to reproduce the observed forward peak in the spin-flip probability, it is necessary to introduce a deformation in the spin-orbit potential which is approximately twice the deformation in the ordinary potential. A backward peak is also obtained in the calculations. However, the predicted magnitude of this peak is between 1.5 and 3 times lower than the observed magnitude. (Diss. Abstr.)

50539 PROTON POLARIZATION IN ELASTIC SCATTERING BY CARBON. Soroka, V. I.; Pucherov, N. N.; Artsimovich, M. V. (Inst. of Physics, Kiev). Ukr. Fiz. Zh., 13: 1057-60(July 1968). (In Russian).

By the method of double scattering, an angular distribution of proton polarization was measured for elastic scattering by carbon at the energies 3.5 and 3.71 MeV. The polarization angular dependence differed noticeably from the predicted one according to the shifts of the Reich phases. Sets of phases are presented which satisfactorily describe the experimental data. (auth)

50540 THE $^{12}C(n,\alpha_0)^9Be$ REACTION AT 13.9 AND 15.6 MeV. Brendle, M.; Moerike, M.; Staudt, G.; Steidle, G. (Univ., Tuebingen, Ger.). Z. Naturforsch., 23a: 1229-30(Aug. 1968).

The differential cross section for the reaction $^{12}C(n,\alpha_0)^9Be$ at incident neutron energies of 13.9 and 15.6 MeV was measured using a counter telescope in which two CO_2-filled proportional counters were followed by an Si detector to record the α spectra. (J.W.R.)

50541 ^{3}He-INDUCED REACTIONS IN ^{6}Li AND ^{7}Li. Bluemel, Van Fonken Wilford. Urbana, Ill., Univ. of Illinois, 1967. 62p.

Thesis.

^6Li and ^7Li targets were bombarded by ^3He particles at 21.2, 24.5, and 26.8 MeV. A solid-state-detector telescope detected ^3He and α particles, plus some tritons, coming from the target. The forms of the angular distributions were characteristic of direct interaction processes. Angular distributions of the following reactions were measured: $^6Li(^3He,^3He)^6Li(g.s.)$; $^6Li(^3He,$ $^{3\prime}He)^6Li(2.184)$; $^7Li(^3He,^3He)^7Li(g.s.)$; $^7Li(^3He,^{3\prime}He)^7Li(0.478)$; $^7Li(^3He,^{3\prime}He)^7Li(4.63)$; $^7Li(^3He,\alpha)^6Li(g.s.)$; $^7Li(^3He,\alpha')^6Li(2.18)$; $^7Li(He,\alpha')^6Li(3.562)$; $^7Li(^3He,t)^7Be(g.s.)$; $^7Li(^3He,t')^7Be(0.431)$; $^7Li(^3He,t')^7Be(4.55)$. Each reaction is discussed, and the angular distributions are compared with appropriate experimental results from other laboratories. A possible approach to interpreting the data is suggested. (Diss. Abstr.)

50542 OBSERVATION OF THE NEW ISOTOPE ^{17}C USING A COMBINED TIME-OF-FLIGHT PARTICLE-IDENTIFICATION TECHNIQUE. Poskanzer, A. M.; Butler, G. W.; Hyde, E. K.; Cerny, J.; Landis, D. A.; Goulding, F. S. (Univ. of California, Berkeley). Phys. Lett., 27B: 414-16(Sept. 2, 1968).

Addition of time-of-flight to the particle-identification technique used previously for the study of light nuclei ejected from uranium by 5.5-GeV protons has established the existence of ^{17}C and the particle instability of ^{13}Be. (auth)

50543 WIDTHS OF THE 6.92(2^+) AND 7.12(1^-) MeV LEVELS IN ^{16}O. Evers, D.; Fluegge, G.; Morgenstern, J.; Retz-Schmidt, T. W.; Schmidt, H.; Schmidt, J. W.; Skorka, S. J. (Univ., Hamburg). Phys. Lett., 27B: 423-4(Sept. 2, 1968).

A nuclear resonance fluorescence measurement of the widths of the 6.92 (2^+) and 7.12 (1^-) MeV levels in ^{16}O yielded 80 ± 7 MeV and 47 ± 6 MeV, respectively. (auth)

50544 ON THE POSITIVE-PARITY STATES OF ^{19}F. Shima, Kunihiro; Sakisaka, Masakatsu (Kyoto Univ.). Mem. Fac. Eng., Kyoto Univ., 29: 483-7(Nov. 1967).

A calculation of rotation-particle coupling was done for the low-lying and positive-parity states of ^{19}F. The level orders attributed to the K = $^1/_2$ and $^3/_2$ bands were calculated, in which the moments of inertia were chosen as different values. The level energies up to about 5-MeV excitation can be fitted with the observed levels more satisfactorily than other theoretical predictions. (NSA of Japan)

50545 ON THE MAGNETIC MOMENT OF THE ISOTOPE ^{12}B. Wells, J. C. Jr.; Williams, R. L. Jr.; Pfeiffer, L.; Madansky, L. (Johns Hopkins Univ., Baltimore). Phys. Lett., 27B: 448-9 (Sept. 2, 1968).

Measurements of relaxation times of the nuclear polarization of the isotope ^{12}B have been performed in several host metals. The nuclear magnetic moment as determined by the resonant NMR frequencies is corrected by assuming the validity of the Korringa relation for the Knight shift. (auth)

50546 DIPOLE PHOTOABSORPTION IN ^{9}Be. Majling, L. (Nuclear Research Inst., Rez, Czechoslovakia); Kukulin, V. I.; Smirnov, Yu. F. Phys. Lett., 27B: 487-9(Sept. 16, 1968).

The absorption spectrum for dipole gamma rays with energies below 35 MeV is calculated using the many-particle nuclear shell model. (auth)

50547 THE INTERACTION OF HIGH-ENERGY ELECTRONS WITH ^{6}Li AND ^{7}Li. Hutcheon, Ronald Malcolm. Saskatoon, Canada, Univ. of Saskatchewan, 1968. 173p.

Thesis.

The 140-MeV Saskatchewan electron linear accelerator was used to measure the electron scattering and electrodisintegration cross sections of ^6Li and ^7Li. The inelastic electron scattering form factors were measured for the low-lying excited states of both isotopes, and in some cases there are large discrepancies between the present and previous results. Most of these were traced to the presence of a very large quasi-continuous cross section underlying the narrow levels of both ^6Li and ^7Li. Because of the improved resolution, in the present experiment the narrow peaks were resolved from the continuous background whereas, in previous cases, a large portion of the continuous cross section had been included in the area of the peaks. The present results have greatly simplified the interpretation of the low excitation energy levels in both nuclei. The theoretical fits to the ^6Li elastic and inelastic form factors indicate that the data can not be fitted using a simple harmonic oscillator model with the same oscillator parameter for the s- and p-shells. However, consistent results are obtained using an s-shell parameter of approximately 1.63 fm and a p-shell parameter of approximately 2.0 fm. In ^6Li the broad quasi-continuous cross section is peaked at approximately 4 MeV and has a width of about 2.5 MeV, while in ^7Li the peak in the cross section is at approximately 5 MeV and the width is much larger. An attempt was made to determine some of the properties of these broad "levels" which seem to be associated with the α-d and α-t decay of ^6Li and ^7Li, respectively. In ^7Li, the reduced E2 transition probabilities of the 4.63- and 6.6-MeV states were measured, and tend to verify a rotational model for the first four states of ^7Li. The giant resonance regions of the lithium isotopes were studied at both low and high momentum transfers by inelastic electron scattering and by electrodisintegration. The data from the latter experiments are very difficult to interpret, but, although they yielded no new nuclear information an approximate test of the virtual photon formalism was provided. The present low momentum transfer inelastic electron scattering spectra taken in the giant resonance region are quite different from previous results and indicate a great deal of structure. The high momentum transfer data taken in the same region of excitation energy suggest that an α-d model may be applicable to ^6Li when the interaction wavelength is short enough. (Disser. Abstr.)

50548 DEUTERON VECTOR POLARIZATION IN (p,d) REACTIONS AT 185 MeV. Ingemarsson, A.; Johansson, A.; Tibell, G. (Univ. of Uppsala). Phys. Lett., 27B: 439-40 (Sept. 2, 1968).

The vector polarization of deuterons from (p,d) reactions, induced by 185-MeV protons in ^{9}Be, ^{12}C, and ^{28}Si, was measured using a carbon polarimeter. (auth)

50549 PROTON DECAY OF ANALOG STATES FORMED IN THE (d,n) REACTION. Cue, N.; Richard, Patrick (Univ. of Washington, Seattle). Phys. Rev., 173: 1108-25(Sept. 20, 1968).

Cross sections were measured for proton decay from isobaric analog states (IAS; $T = T_z + 1$) formed in the (d,n) reactions on the following targets: ^{16}O, ^{27}Al, ^{64}Ni, ^{68}Zn, ^{89}Y, ^{90,91,92,94}Zr, ^{92,94,98}Mo, ^{114,116,118,120}Sn, and ^{206}Pb. A ΔE-E detector telescope having a combined energy resolution of about 34 keV was used. Excitation functions ($\theta_{lab} = 170°$) were obtained with the deuteron energies ranging from the (d,n) threshold of the IAS to about 16 MeV. Angular distributions were also obtained at the various incident energies for a few of the strong transitions. The cross sections are large only for reactions leading back to the target ground state when, in addition, the neutron decay channels are closed to the IAS. Particular attention is paid to the large variations in the cross sections for reactions proceeding through the analogs of $2d_{5/2}$, $3s_{1/2}$, and $2d_{3/2}$ states in Zr, Mo, and Sn isotopes. At incident energies several hundred keV above the (d,n) threshold, these variations are shown to be consistent with a sequential process in which the (d,n) formation mechanism is direct, when the decay through the spreading width is explicitly taken into account in the branching ratios. However, the over-all energy dependence of the (d,n) cross sections, particularly near threshold, deviate sharply from that predicted by a simple direct process in the stripping model. From the study of the angular distributions of the decay to the 0^+ ground state from the $d_{5/2}$(g.s.) IAS in ^{*91}Nb and ^{*93}Tc, the m-substate populations of the IAS are extracted. The values at energies near threshold suggest the importance of spin-orbit interactions in the (d,n) formation mechanism. (auth)

50550 THE (^{3}He,p) AND (α,d), TWO-NUCLEON STRIPPING REACTIONS ON ^{12}C AND ^{16}O: MECHANISM AND NUCLEAR SPECTROSCOPY. Mangelson, Nolan Farrin. Berkeley, Calif., Univ. of California, 1967. 180p.

Thesis.

Spectra and angular distributions were obtained for the reaction and conditions listed: ^{12}C(^{3}H,p)^{14}N at $E(^{3}He) = 20.1$ MeV, from $\theta_{lab} = 8°$ to 170° for ^{14}N excited states below 13-MeV excitation; ^{12}C(^{3}He,^{3}He)^{12}C at $E(^{3}He) = 20.1$ MeV, from $\theta_{lab} = 8.5°$ to 62.5° for the ground state and 4.433-MeV state of ^{12}C; ^{16}O(^{3}He,p)^{18}F at $E(^{3}He) = 19.8$ MeV, from $\theta_{lab} = 9°$ to 170° for ^{18}F excited states below 11.3-MeV excitation; ^{16}O(α,d)^{18}F at $E(\alpha) = 40.3$ MeV, from $\theta_{lab} = 8°$ to 80° for ^{18}F excited states below 12.7-MeV excitation. Distorted-wave calculations of angular distributions and relative cross sections for the two (^{3}He,p) reactions were compared to experimental values. Agreement was found when a spin-independent interaction potential was used. Nuclear wave functions used in the calculations were discussed. Spectroscopic and configuration assignments were made or confirmed on the basis of excitation energy, angular distribution, comparison of (α,d) and (^{3}He,p) results, relative total cross section, and comparison of experimental quantities to the DW calculations. The following assignments were made for ^{14}N. A spin and parity assignment of 2^- and a tentative assignment of 4^+ were made for the 9.388- and 10.85-MeV, T = 0 levels, respectively. Suggested configurations were made for the 8.979-, 10.213-, and 10.85-MeV levels. Configurations and J^π values of 3^+ and 4^+ were suggested for ^{18}F levels at 3.358 and 5.594-MeV, respectively. Configurations and J^π, T values were confirmed for some levels; and T = 0 assignments were made for a large number of levels. A new ^{18}F level at an excitation energy of 8.596 MeV was identified. (Disser. Abstr.)

50551 CROSS SECTION OF THE ^{9}Be(^{6}He,^{4}He)^{11}Be REACTION. Stepancic, B.; Popic, R.; Aleksic, M. (Boris Kidric Inst., Belgrade). Fizika (Zagreb), 1: 31-9(July 1, 1968).

The energy averaged cross section of the reaction ^{9}Be(^{6}He,$^{4}\alpha$)^{11}Be was measured. The determined value (11 ± 4 mb), compared with the theoretically calculated value, indicates that this reaction proceeds via a direct mechanism. (auth)

50552 INVESTIGATION OF THE MECHANISM OF ^{12}C(π^-,π^-p)^{11}B REACTION AT THE π^- MOMENTUM 1.04 GeV/c. Aganyants, A. O.; Bayukov, Yu. D.; Deza, V. N.; (and others) (Inst. of Theoretical and Experimental Physics, Moscow). Phys. Lett., 27B: 590-3(Sept. 30, 1968).

The characteristic conditions which are necessary for the identification of the ^{12}C(π^-,π^-p)^{11}B reaction mechanism are obtained. The ^{12}C proton width is determined. It is concluded that the pole mechanism dominates only in the region of recoil momenta $\lesssim$100 MeV/c. (auth)

50553 DOUBLE STRIPPING CALCULATION OF THE ^{9}Be(^{6}He,^{4}He)^{11}Be REACTION. Maric, Z.; Zakula, R. (Boris Kidric Inst., Belgrade). Fizika (Zagreb), 1: 41-5(July 1, 1968).

The total cross section in a double stripping picture of the ^{9}Be(^{6}He,α)^{11}Be reaction was calculated assuming that the first two levels of the final nucleus take part in the reaction. Harmonic oscillator functions were used for the two nuclei. The calculation was performed in the plane-wave Born approximation using the Gaussian form of the interaction Hamiltonian. Good agreement with the experimental result was obtained. (auth)

50554 OPTICAL-MODEL CALCULATION OF THE ^{9}Be(^{3}He,^{3}He)^{9}Be ELASTIC SCATTERING. Park, J. Y. (North Carolina State Univ., Raleigh). Can. J. Phys., 46: 1967-72 (Sept. 1, 1968).

An optical-model analysis of the elastic scattering of 6.0- and 8.0-MeV ^{3}He particles on ^{9}Be was performed with and without spin-orbit coupling. Good agreement with data is obtained, indicating the applicability of the optical model in describing the elastic scattering of ^{3}He particles from such light nuclei as ^{9}Be. Inclusion of spin-orbit interaction is found to improve fits, especially at backward angles. Almost equally good results are obtained by volume or surface absorption, although surface absorption gives slightly better fits at 8.0 MeV. Parameters giving the optimum fits to the data are presented and several ambiguities in the potential are discussed. (auth) (CANADA)

50555 NEUTRON EMISSION FOLLOWING MUON CAPTURE AND RADIATIVE PION CAPTURE IN ^{12}C. Kelly, Francis J. (Naval Ordnance Lab., Silver Spring, Md.); Ueberall, H. Nucl. Phys., A118: 302-12 (1968).

Muon capture, and even more so, radiative pion capture, represent a means of studying nuclear structure, by observing the neutrons emitted subsequently to the capture process, which stem from the decay of (mainly giant resonance) states excited during capture. In the radiative capture of pions, the neutron energies may be determined by the time-of-flight method using the gamma ray as a coincidence signal; in addition, the photon spectra themselves may be observed. Gamma and neutron spectra were calculated using the Kammura-Ikeda-Arima model of the giant resonance in ^{12}C and compared our results with those of the earlier model of Gillet, Lewis, deForest and Walecka. (auth)

50556 SHELL-MODEL CALCULATIONS IN THE ^{16}O REGION WITH THE TABAKIN POTENTIAL. de Takacsy, N. (McGill Univ., Montreal. Loyola Coll., Montreal). Can. J. Phys., 46: 2091-2106(Sept. 15, 1968).

Shell-model calculations are performed with the Tabakin potential for the simplest configurations in ^{14}N, ^{15}O, ^{16}O, ^{17}O, ^{18}O, and ^{18}F. The second-order ladder diagrams are calculated in relative coordinates, using harmonic oscillator intermediate states; all second-order corrections to the effective interaction are included. (auth) (CANADA)

50557 BREMSSTRAHLUNG CROSS-SECTION MEASUREMENTS ON Be AT INCIDENT ELECTRON ENERGIES OF 1.0 AND 2.0 MeV. Rester, D. H. (Ling-Temco-Vought, Inc., Dallas). Nucl. Phys., A118: 129-37(1968).

Electron-bremsstrahlung cross sections due to bombardment of Be targets with 1.0 and 2.0 MeV electrons were measured. Angles of emission at which cross-section values were obtained ranged from 0 to 45° at 1.0 MeV and 0 to 20° at 2.0 MeV. At both energies, the electron–electron bremsstrahlung components were discernible with end-points varying with emission angle as predicted by the kinematics. A maximum contribution due to electron–electron interactions at each energy of about 30% of the nuclear charge bremsstrahlung was observed. (auth)

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Refer also to abstracts 49099, 49162, 50522, 50530, 50538, 50548, 50549, 50606, 50616, 50641, 50643, 50662, 50670, 50675, and 50689.

50558 (AEEW-R-597) THERMAL NEUTRON CAPTURE CROSS-SECTIONS OF COBALT. Story, J. S. (Atomic Energy Establishment, Winfrith (England)). May 1968. 13p. Dep. CFSTI. UK 2s. 6d.

Experimental data on the thermal neutron capture cross section of cobalt and the cross sections for activation of the 10.5-min and 5.26 yr isomeric states of ^{60}Co are summarized, and the following weighted mean values are derived: $\sigma_{gA} = 37.55 \pm 0.13$ barns and $\sigma_{act} = 37.50 \pm 0.13$ barns for activation of the 5.26-yr

ground state of ^{60}Co both directly and by decay of the isomeric state. For activation of the 10.5-min isomeric state of ^{60}Co $\sigma_{act} = 19.9 \pm 0.91$ barns. A summary is made also of the experimental data on the half-lives of the ^{60}Co isomers. (auth) (UK)

50559 (ANL-7387) COMPILATION OF ENDF/B DATA FOR MAGNESIUM, TITANIUM, VANADIUM, MOLYBDENUM, AND GADOLINIUM. Pennington, E. M.; Gajniak, J. C. (Argonne National Lab., Ill.). Mar. 1968. Contract W-31-109-eng-38. 122p. Dep. CFSTI.

The compilation of ENDF/B neutron cross-section data for the materials magnesium, titanium, vanadium, molybdenum, and gadolinium is presented. All the data in the ENDF/B format are listed, and graphs of much of the data are presented. (auth)

50560 (RLO-1062-681) NUCLEAR PHYSICS GROUP ANNUAL PROGRESS REPORT FOR PERIOD ENDING JULY 31, 1968. (Oregon State Univ., Corvallis. Dept. of Physics). Contract AT(45-1)-1062. 88p. Dep. CFSTI.

The experimental research program dealt with α inelastic scattering by ^{90}Zr, electric deuteron polarization in stripping reactions, and decay of ^{109}Pd and ^{111}Pd, while the theoretical research program dealt with charge-exchange reactions, antisymmetric nuclear scattering, coupled-channel codes, the (p,n) reaction on ^{14}C, coupled-channel wave functions in rearrangement collisions, first-order nuclear transition rates, nuclear structure calculations, low-energy nucleon tunneling in heavy-ion reactions, intermediate resonances, and approximation of nonseparable potentials. The development and modification of the cyclotron facility is also summarized. (D.C.W.)

50561 DEPENDENCE OF INTEGRATED CROSS SECTIONS ON THE ROTATIONAL STATES OF ^{23}Na IN THE REACTION ^{25}Mg(d,α)^{23}Na AT 21 MeV. Priest, J. R. (Miami Univ., Oxford, Ohio). Phys. Lett., 27B: 497-8(Sept. 16, 1968).

The integrated cross sections for production of $K = \frac{5}{2}$ states in the ^{25}Mg(d,α)^{23}Na reaction obey a linear relation of the form $\sigma = a(2I + 1) - b$. A comparison of these results with similar data from the ^{27}Al(d,α)^{25}Mg reaction suggests that the negative intercept is a consequence of band mixing in the states of ^{23}Na. (auth)

50562 MEASUREMENT OF THE ^{35}Cl(p,n)^{35}Ar THRESHOLD AND ITS RELEVANCE TO THE VECTOR COUPLING CONSTANT. Cramer, J. G.; Mangelson, N. F. (Univ. of Washington, Seattle). Phys. Lett., 27B: 507-9(Sept. 16, 1968).

A proton laboratory energy of 6968.9 ± 3.5 keV was found for the ^{35}Cl(p,n)^{35}Ar reaction threshold. This value, taken together with other available data, implies a vector coupling coefficient of $G_V = 1.392 \pm 0.020 \times 10^{-49}$ erg cm^3 for the ^{35}Ar ground-state positron decay. (auth)

50563 NUCLEAR MAGNETIC MOMENTS OF ^{83}Kr AND ^{39}K. Brinkman, D. (Univ., Zurich). Phys. Lett., 27A: 466-7(Sept. 9, 1968).

The nuclear magnetic moment of ^{83}Kr was remeasured to correct for a density-dependent resonance frequency shift: $|\mu(^{83}Kr)| = (0.967221 \pm 0.000012)$ nm. As a by-product, the moment of ^{39}K was redetermined. (auth)

50564 GAMMA RAYS FROM THERMAL NEUTRON CAPTURE IN NATURAL ARGON. Skeppstedt, Oe.; Hardell, R.; Arnell, S. E. (Chalmers Univ. of Technology, Goteborg). Ark. Fys., 35: 527-37(1968).

Thermal neutron capture gamma rays from natural argon were measured by means of Ge(Li) spectrometers. Energies and intensities of the gamma rays from the product nuclei ^{37}Ar and ^{41}Ar are reported. Decay schemes of ^{37}Ar and ^{41}Ar are presented including gamma-ray branching ratios and more accurate energy values of some low-lying levels in ^{41}Ar. The ^{40}Ar(d,p)^{41}Ar and ^{40}Ar(n,γ)^{41}Ar reactions were compared and found to give a good correlation between the strengths in the (d,p) and (n,γ) reactions. (Sweden)

50565 PRECISE MUONIC Kα ISOTOPE SHIFTS FOR NUCLIDES FROM Si TO Sn. Ehrlich, R. D. (Univ. of Chicago). Phys. Rev., 173: 1088-1100(Sept. 20, 1968).

Measurements of muonic Kα isotope shifts for 29 nuclides are described in detail. In most cases, these measurements provide unique information on changes in the nuclear charge distribution. The model dependence of the changes in rms radii derived from the muonic shifts (necessary for comparison with electronic data) is discussed in detail. The muonic shifts in Sr, Zr, and Sn are compared with the relevant electronic measurements; the Ca isotope shifts are compared with the results of recent electron scattering results. Strong shell effects are confirmed at N = 28 and 88, viz., ^{48}Ca and ^{88}Sr are found to have smaller rms charge radii than ^{40}Ca and ^{86}Sr. Precise values are also obtained for the K-Ca isotone shifts and for the absolute energies of nine Kα transitions. (auth)

50566 FIRST EXCITED STATE OF ^{35}S. ter Veld, L. K.; van der Mark, Th. W. (Univ., Groningen, Netherlands). Phys. Rev., 173: 1101-3(Sept. 20, 1968).

A hitherto unreported level in ^{35}S was found at 1.56 MeV with the ^{37}Cl(d,$\alpha\gamma$)^{35}S reaction. Measurements were made on the decay of this level and of the four previously known levels up to an excitation energy of 3 MeV. A J^π value of $\frac{1}{2}^+$ for the 1.56-MeV level, as predicted by Glaudemans from shell-model calculations, is not in disagreement with these measurements or those of others. There is convincing evidence, however, that neither the second level at 1.99 MeV nor the third level at 2.35 MeV corresponds to a level predicted in the same calculations to lie at 2.07 MeV with spin and parity of $\frac{5}{2}^+$. (auth)

50567 INELASTIC ELECTRON SCATTERING FROM ^{26}Mg AT 180°. Bendel, W. L.; Fagg, L. W.; Tobin, R. A.; Kaiser, H. F. (Naval Research Lab., Washington, D. C.). Phys. Rev., 173: 1103-7(Sept. 20, 1968).

The 180° inelastic electron scattering from ^{26}Mg was studied at bombarding energies of 39 and 56 MeV. Eight magnetic dipole transitions were from 1^+ states at 8.52, 9.24, 9.67, 10.18, 10.63, 11.20, 13.33, and 13.66 MeV. The transition radii and ground-state radiation widths were calculated. (auth)

50568 INTENSITIES OF INNER BETA GROUPS IN ^{47}Ca AND SHAPES OF NONSTATISTICAL ALLOWED OUTER GROUPS IN ^{47}Ca AND ^{32}P. Fischbeck, H. J. (Argonne National Lab., Ill.). Phys. Rev., 173: 1078-88(Sept. 20, 1968).

Beta-gamma coincidence measurements on the decay of ^{47}Ca give 0.087 ± 0.030% per decay for the intensity of the first-forbidden inner β transition to the 767-keV $\frac{3}{2}^+$ level in ^{47}Sc. This is in agreement with previous intensity limits deduced from γ-transition intensity measurements. A limit of <0.004% per decay for the second-forbidden β transition to the 808-keV $\frac{5}{2}^-$ level was obtained from the β-γ coincidence measurements. The intensity of the inner β groups is therefore too weak to cause the distortion of the allowed ground state-to-ground state β spectrum reported previously. The shape of the 1988-keV ground state-to-ground state β transition was measured on the Argonne double-lens spectrometer. A deviation from statistical shape similar but not identical to previous measurements is observed. The energy dependence of the shape factor can be expressed by an empirical expression of the form $C = k(1 + aW + bW^{-1} + cW^2)$. A good but not unique fit is obtained for $a = -0.035 \pm 0.012$, $b = -0.037 \pm 0.013$, $c = 0$. This result differs from previous interpretations. The spectrum of the possibly l-forbidden $1^+ \rightarrow 0^+$ allowed β transition in ^{32}P was remeasured. The energy dependence of the experimentally observed shape factor can be expressed as $C = 1 - (0.017 \pm 0.002)W$, similar to previous measurements, but other interpretations are also possible. The weak γ transition of 1878 keV in the ^{47}Ca decay has been confirmed. The half-life of ^{47}Ca was measured and found to be 4.51 ± 0.05 days. (auth)

50569 GAMMA RAYS FROM THE ^{45}Sc(p,p'γ) REACTION. Chasman, C.; Jones, K. W.; Ristinen, R. A. (Brookhaven National Lab., Upton, N. Y.). Phys. Rev., 173: 1072-7(Sept. 20, 1968). (BNL-12286).

Gamma rays emitted from the ^{45}Sc(p,p'γ) reaction were observed at proton energies of 2.8, 3.2, and 3.6 MeV. A total of 28 γ-ray transitions were observed to be associated with the decay of 14 levels known from previous reaction studies. Some possible spin assignments were deduced from the observed γ-ray branching ratios. (auth)

50570 NUCLEAR STRUCTURE OF ^{22}Na. V. DOPPLER-SHIFT ATTENUATION MEASUREMENTS. Paul, P.; Olness, J. W.; Warburton, E. K. (Brookhaven National Lab., Upton, N. Y.). Phys. Rev., 173: 1063-71(Sept. 20, 1968).

The mean lifetimes of seven nuclear levels of ^{22}Na were measured by the Doppler-shift attenuation method. The ^{19}F(α,n)^{22}Na reaction was used to populate the levels. γ rays were observed at 0° to the α beam with a Ge(Li) detector. The results, when averaged with previous work, yield the following mean lives (in psec) for the indicated levels: 0.891 (12.25 ± 1.75), 1.528 (3.5 ± 0.6), 1.984 (1.74 ± 0.34), 2.211 (20^{+15}_{-6}), 2.572 (5.7 ± 0.9), 2.969 (0.060 ± 0.013), and 3.059 (0.040 ± 0.01), where the levels are designated by their excitation energies (in MeV). For the five lowest levels the lifetimes were obtained from an analysis of Doppler-shifted line shapes; the remaining two lifetimes were determined from conventional centroid-shift analysis. The latter method also gave a lifetime of 5.2 ± 0.9 psec for the 1.346-MeV level of ^{19}F. Some information was obtained on the M2/E1 mixing ratios of the ground-state and first-excited-state transitions from the $J^\pi = 2^-$ 2.572-MeV level of ^{22}Na. Evidence for a K = 1 odd-parity rotational band in ^{22}Na is discussed. (auth)

50571 ANGULAR-DISTRIBUTION STUDY OF THE $^{65}Cu(^3He, xn)$ REACTION PRODUCTS. Fujiwara, I.; Porile, N. T. (Purdue Univ., Lafayette, Ind.). Phys. Rev., 173: 1055-63(Sept. 20, 1968).

Angular distributions of the $(^3He,n)$ and $(^3He,2n)$ reaction products from ^{65}Cu were measured over the energy range 17 to 32 MeV. The results for the $(^3He,2n)$ reaction, which is known to involve compound-nucleus formation, were compared with the statistical theory of nuclear reactions and were analyzed to yield the average neutron and photon energies as well as the parameters characterizing the distribution in the center-of-mass system. Comparison of the results with similar data for the $^{65}Cu(\alpha,2n)$ reaction indicates that γ-ray emission competes more effectively in the case of the latter, a result that may be correlated with the difference in angular momentum of the two systems. The results for the $(^3He,n)$ reaction are in qualitative agreement with a distorted-wave calculation for a two-proton stripping process. (auth)

50572 LEVEL STRUCTURE OF ^{89}Zr VIA THE REACTION $^{90}Zr(p,d)^{89}Zr$. Taketani, H.; Adachi, M.; Yoshida, Y.; Ogawa, M.; Ashibe, K. (Tokyo Inst. of Tech.). Phys. Lett., 27B: 499-501(Sept. 16, 1968).

Levels in ^{89}Zr up to about 13 MeV were excited via the reaction $^{90}Zr(p,d)^{89}Zr$. The over-all level structure obtained is qualitatively consistent with the concept that most of the levels are due to $1g_{9/2}$, $2p_{1/2}$, $2p_{3/2}$, $1f_{5/2}$, and possibly $1f_{7/2}$ neutron hole states fragmented by isospin splitting and core-polarization effects. (auth)

50573 INFLUENCE OF 2p–1h CONFIGURATIONS ON THE LOW-LYING STATES OF ^{51}Ti. Glover, R. N. (Atomic Weapons Research Establishment, Aldermaston, Eng.); Denning, A.; Brown, G. Phys. Lett., 27B: 434-5(Sept. 2, 1968).

Experimental evidence for 2p–1h configurations in ^{51}Ti is obtained from study of the reaction $^{49}Ti(t,p)^{51}Ti$. To account for the relative intensities of the (t,p) transitions such configurations need to be included in shell-model calculations. (auth)

50574 LOCATION AND ISOSPIN-FORBIDDEN ALPHA DECAY OF THE LOWEST T = 2 STATE IN ^{28}Si. McGrath, R. L.; Hardy, J. C.; Cerny, J. (Univ. of California, Berkeley). Phys. Lett., 27B: 443-5(Sept. 2, 1968).

The excitation energy of the lowest 0^+ T = 2 state in ^{28}Si was measured to be 15.206 ± 0.025 MeV. The state decays predominantly by isospin-forbidden α-particle emission. Its analogue in ^{28}Al was also observed at 5.983 ± 0.025 MeV. (auth)

50575 OCTUPOLE WEAK COUPLING STATES IN ^{55}Mn. Peterson, R. J. (Princeton Univ., N. J.). Phys. Lett., 27B: 446-7(Sept. 2, 1968).

The inelastic scattering of 17.5-MeV protons from ^{55}Mn reveals a multiplet of states exhibiting the same angular distribution as is seen for the collective octupole state of ^{56}Fe. The magnitudes of the cross section are in agreement with the predictions of the weak-coupling model. (auth)

50576 NEW 1^+ STATE IN ^{26}Al. Rosner, B.; Neogy, P.; Polsky, L. (Univ. of Pennsylvania, Philadelphia). Phys. Lett., 27B: 450-1(Sept. 2, 1968).

Study of the $^{24}Mg(^3He,p)^{26}Al$ reaction leads to a new $J^\pi = 1^+$ assignment to the state at 1 852 keV. This state, to which a very strong transition was observed, most probably belongs to the $(d_{5/2})^{-4}(2s_{1/2})^2$ shell-model configuration. (auth)

50577 ELASTIC SCATTERING OF PROTONS BY ^{26}Mg. Mertz, Marvin Clark. Chicago, Illinois Inst. of Tech., 1965. 113p.

Thesis

Differential cross sections for elastic scattering of protons by ^{26}Mg were measured using solid-state diode detectors at laboratory angles of 90.2, 120.3, 135, and 165°. Protons in the energy range from 0.85 to 4.58 MeV, corresponding to excitation energies from 9.10 to 12.72 MeV in ^{27}Al, were obtained from three different electrostatic accelerators at Argonne National Laboratory. About 114 levels were seen; spin and parity were assigned to 25, l values to 16, and tentative spin or l values to 38 more. 35 levels remain unassigned. As expected from shell-model consideration, negative-parity states predominate, contributing about four times the total reduced width of the normal-parity states. Seven of the strongest levels have the right l values, energies, and relative intensities to be isobaric analogs of levels in ^{27}Mg. Good agreement was found with ^{26}Mg (p,γ) work and with the data of a previous low-resolution ^{26}Mg (p,p) experiment. (Disser. Abstr.)

50578 GIANT RESONANCE ELECTROEXCITATION IN ^{28}Si. Gulkarov, I. S.; Afanasyev, N. G.; Savitsky, G. A.; Khvastunov, V. M.; Shevchenko, N. G. (Physico-Technical Inst., Kharkov). Phys. Lett., 27B: 417-19(Sept. 2, 1968).

Inelastic electron spectra with dipole giant resonance excitation in ^{28}Si were measured in the initial energy range 150 to 225 MeV and at scattering angles of 25 to 65°. The experimental data are compared with predictions of a number of models. (auth)

50579 DETECTION AND EFFECTIVE CROSS SECTION OF A (n,2α) REACTION ON ^{39}K WITH 14-MeV NEUTRONS. Hille, P.; Fritsch, A. Oesterr. Akad. Wiss., Math.-Naturwiss. Kl., Sitzungsber., Abt. II, 175: No. 5-7, 145-53(1966). (In German).

An activity with 14.5-day half-life occurring during the irradiation of KNO_3 with 14-MeV neutrons was assigned to ^{32}P. For the effective cross section of the reaction $^{39}K(n,2\alpha)^{32}P$ a value of 127 μ ± 19% was obtained by absolute determination of the ^{32}P activity. The effect of interference reactions and impurities of the KNO_3 samples was estimated and was considered within the limits of error. (tr-auth)

50580 THE $^{22}Ne(^3He,\alpha)^{21}Ne$, $^{24}Mg(^3He,\alpha)^{23}Mg$ AND $^{26}Mg(^3He,\alpha)^{25}Mg$ REACTIONS AT 15 MeV. Joyce, James Martin. Philadelphia, Univ. of Pennsylvania, 1967. 95p.

Thesis.

The $(^3He,\alpha)$ reaction on the nuclei ^{22}Ne, ^{24}Mg, and ^{26}Mg was studied. Of interest were the states excited in the residual nuclei ^{21}Ne, ^{23}Mg, and ^{25}Mg and the structure of the ground states of the target nuclei. The ^{22}Ne target consisted of a reciprocating gas cell filled to a pressure of 2.5 psi with isotopically enriched ^{22}Ne. The ^{24}Mg target was an isotopically enriched foil vacuum evaporated on a carbon backing. The ^{26}Mg target was a vacuum evaporated self-supporting foil of isotopically enriched ^{26}Mg. An array of up to eight silicon surface barrier detectors was used to measure the angular distributions of the elastically scattered ^3He particles and of the reaction alpha particles in a 61-cm-diameter scattering chamber. The ^3He elastic scattering angular distributions were analyzed with an optical model search code. The angular distributions of the alpha particles leaving the residual nuclei in their ground and low-lying excited states were compared to those predicted by distorted wave Born approximation calculations. l-value assignments for the states excited in the residual nuclei were made. Spectroscopic factors were extracted wherever possible. (Disser. Abstr.)

50581 RESOLUTION OF AMBIGUITIES IN THE OPTICAL-MODEL POTENTIAL FOR ^{16}O–^{24}Mg FROM ELASTIC SCATTERING DATA NEAR THE COULOMB BARRIER. Eck, J. S.; Lasalle, R. A.; Robson, D. (Florida State Univ., Tallahassee). Phys. Lett., 27B: 420-2(Sept. 2, 1968).

Excitation functions for ^{16}O–^{24}Mg elastic scattering taken near the Coulomb barrier are used to reduce the number of phase-equivalent discrete ambiguities in the real optical-model potential well depth. For a Woods–Saxon form factor, a nuclear radius of 6 fm and a diffuseness parameter of 0.6 fm the real optical-model potential well depth for ^{16}O–^{24}Mg is found to be U = 45 ± 10 MeV. The results are quite insensitive to the value of the absorption term in the optical potential. (auth)

50582 GAMMA-RAY ENERGY OF ^{40}K. Yoshizawa, Yasukazu (Osaka Univ.); Morii, Tsuneo; Katoh, Toshio; Gotoh, Hiroshi. J. Nucl. Sci. Technol. (Tokyo), 5: 432-3(Aug. 1968).

Gamma-ray energies of ^{82}Br and ^{40}K were measured with an error of the order of 0.5 keV using a 20-cc Ge(Li) detector with a 1024-channel pulse-height analyzer. An average value of 1460.9 ± 0.3 keV was obtained for the ^{40}K γ ray, which can be used as a standard. (J.W.R.)

50583 ISOMERIC CROSS-SECTION RATIO FOR (n,2n) REACTIONS INDUCED BY 14.7-MeV NEUTRONS. Minetti, B.; Pasquarelli, A. (Politecnico, Turin). Nucl. Phys., A118: 449-60(1968).

The activation cross sections for (n,2n) reactions induced by 14.7 MeV neutrons were measured in ^{85}Rb, ^{87}Rb, ^{88}Sr, ^{90}Zr, ^{92}Mo, ^{102}Pd, ^{107}Ag and ^{109}Ag. For all the reactions, it was possible to measure the isomeric cross-section ratio. This ratio was analyzed using the Huizenga-Vandenbosch method. Estimates were obtained for the parameter σ which characterizes the spin dependence of the nuclear level density. (auth)

50584 $^{39}K(d,^3He)^{38}Ar$ AND THE s-d SHELL STRUCTURE OF ^{38}Ar. Wildenthal, B. H.; Newman, E. (Oak Ridge National Lab., Tenn.). Nucl. Phys., A118: 347-60(1968).

The positive-parity level structure of ^{38}Ar was investigated with the $^{39}K(d,^3He)^{38}Ar$ reaction on a KI target at a bombarding energy of 34.5 MeV. Seven residual levels were found to be strongly excited, three with $l_p = 2$ characteristics at 0.00, 2.17 and 7.11 MeV excitation energy and four with predominant $l_p = 0$ characteristics at 3.94, 4.57, 5.15 and 5.55 MeV excitation energy. These experimental results were examined from the viewpoint of several recent shell-model calculations. No extant calculations provide a quantitative interpretation of the occurrence of as many as four strong

l = 0 levels. It seems likely that the extra l = 0 levels arise from 2p-4h excitations into the 1f shell and are populated via the large components of the $(s_{\frac{1}{2}}^{-1}\text{-}d_{\frac{5}{2}}^{-1})$ configuration mixed into these 2p-4h states. The (d,^{3}He) reaction on the ^{127}I in the target yielded evidence that the $\frac{5}{2}^+$ ground state of this nucleus contains significant $2d_{\frac{5}{2}}$ admixtures. (auth)

50585 HIGH-RESOLUTION FAST-NEUTRON CROSS SECTIONS OF IRON. Barnard, E. (Atomic Energy Board, Pelindaba, S. Africa); de Villiers, J. A. M.; Engelbrecht, C. A.; Reitmann, D.; Smith, A. B. Nucl. Phys., A118: 321-46(1968).

The interactions between Fe and neutrons with energies between 0.3 and 1.5 MeV were studied using time-of-flight methods. Particularly, the total and inelastic scattering cross sections were determined with good energy resolution, and a considerable amount of structure was observed. (auth)

50586 ^{89m}Y EXCITATION CROSS-SECTION AT INELASTIC REACTOR NEUTRON SCATTERING. Damburg, N. A.; Pelekis, L. L. (Inst. of Physics, Riga). Latv. PSR Zinat. Akad. Vestis, Fiz. Teh. Zinat. Ser., No. 3, 127(1968). (In Russian).

An activation method was used to measure the cross section of the reaction ^{89}Y(n,n')^{89m}Y in the neutron spectrum of the reflector of the IRT reactor. An absolute method for measuring the fast neutron cross section yielded a value of 400 ± 100 mbarns. (R.V.J.)

50587 LIFETIMES AND DECAY MODES OF ENERGY LEVELS IN ^{25}Mg. Sharpey-Schafer, J. F. (Atomic Energy of Canada, Ltd., Chalk River, Ont.); Ollerhead, R. W.; Ferguson, A. J.; Litherland, A. E. Can. J. Phys., 46: 2039-54(Sept. 15, 1968).

Lifetimes of energy levels in ^{25}Mg were measured using the Doppler-shift attenuation method. The levels were excited by the ^{25}Mg(p,p'γ) reaction with incident proton energies between 3.8 and 7.0 MeV. The gamma rays were detected in a three-crystal spectrometer consisting of a 40 cm^3 Ge(Li) detector surrounded by a large NaI(Tl) crystal in the form of a split annulus. Mean lifetimes found, given in fs, are: τ(1611-keV level) = 27±, τ(1962) = 600±, τ(2565) = 59 ± 26, τ(2736) = 288 ± 20, τ(2803) = 27 ± 6, τ(3399) = 33 ± 19, τ(3408) < 20, τ(3903) < 20, τ(3969) = 24 ± 11, τ(4055) = 53 ± 10, and τ(5005) < 26. The decay modes and branching ratios of levels up to 4055-keV excitation are given. The results are compared with the mirror nucleus ^{25}Al and are discussed in terms of the collective model. (auth) (CANADA)

50588 LIFETIME MEASUREMENT OF THE 46-keV STATE IN ^{76}As. Henry, L. C.; Kennett, T. J. (McMaster Univ., Hamilton, Ont.). Can. J. Phys., 46: 1984-8(Sept. 1, 1968).

The lifetime of an excited state of ^{76}As populated in the (n,γ) reaction and observed to decay by 46-keV gamma radiation has been studied, using a multichannel analyzer to record the output of a time-to-amplitude converter. The use of logic modules to determine the differential linearity of the system was studied in detail and is discussed. Experimental findings correlated with results of other studies suggest the following: the lifetime, measured to be 1.93 ± 0.06 μs, is that of the low-lying 46-keV level of ^{76}As characterized by J^π values of 1^+, 2^+, or 3^+, strongly populated by direct E1 radiation from the 2^- and or 3^- capture state and depopulated by E1 radiation to the 2^- ground state. (auth) (CANADA)

50589 EVIDENCE AGAINST PROPOSED HIGH-SPIN LEVELS AT 3660 AND 2824 keV IN ^{44}Ca. King, J. D.; Lalovic, B.; Taylor, H. W. (Univ. of Toronto). Can. J. Phys., 46: 2119-22(Sept. 15, 1968).

Experimental evidence is presented which shows no γ rays with energies of either 810 or 1666 keV or levels at 3660 and 2824 keV which would be excited by the decay of the 2.3-day isomeric state of ^{44}Sc. (F.S.A.) (CANADA)

50590 PROTON PICK-UP FROM THE EVEN CALCIUM ISOTOPES. Santo, R. (Max-Planck Institut fuer Kernphysik, Heidelberg); Stock, R.; Bjerregaard, J. H.; Hansen, Ole; Nathan, O.; Chapman, R.; Hinds, S. Nucl. Phys., A118: 409-22(1968).

The ^{42,44,46,48}Ca(t,α) proton pick-up reactions were investigated at about 13-MeV incident energy. Transition Q-values and α-particle angular distributions were measured for the stronger transitions. A common intensity scale was established by means of (t,α) reactions from a target consisting of known amounts of each of the even Ca isotopes. Assignments of l-values were made on the basis of the α-particle angular distributions. Relative spectroscopic factors were obtained by means of a DW analysis for the strongest $1f_{\frac{7}{2}}$, $1d_{\frac{3}{2}}$ and $2s_{\frac{1}{2}}$ transitions. Some $1f_{\frac{7}{2}}$ transitions were observed for the targets of ^{40,42,44,46}Ca but not for ^{48}Ca. (auth)

50591 NUCLEAR PHOTOEXCITATION OF THE 7368-keV LEVEL OF ^{66}Zn BY LEAD CAPTURE GAMMA RAYS. Shikazono, N.; Kawarasaki, Y. (Japan Atomic Energy Research Inst., Tokyo). Nucl. Phys., A118: 114-28(1968).

A nuclear resonant scattering experiment was carried out of the lead capture gamma rays from natural zinc. Twenty-nine de-excitation gamma rays from the resonant level were observed. A comparison of the energies of the low-lying levels with the energies of the inelastically scattered gamma rays and the low-energy cascade gamma rays established the resonant isotope as ^{66}Zn. Angular distribution measurements of the scattered gamma rays were performed to assign spins to low-lying levels of ^{66}Zn. From the results of these measurements, the decay scheme for the 7368 keV level of ^{66}Zn is proposed. (auth)

50592 THE REACTION (γ,α) IN Ge AND Nb. Kraft, G.; Kosiek, R.; Mundhenke, R.; Winter, J. (Univ. Heidelberg). Nucl. Phys., A118: 25-32(1968).

Natural Ge and Nb were irradiated with 32.5-MeV bremsstrahlung. The energy spectra of the emitted α particles were measured at 90° with respect to the γ beam for α energies between 5 and 14 MeV using solid-state detectors. Yield values were found to be 1.24 ± 0.18 and 0.51 ± 0.07 μb/MeV·sr for Ge and Nb. Single compound nucleus calculations show qualitative agreement with the measurements. Observed structures in Ge at E_α = 6.8 and 8.2 MeV and in Nb at E_α = 10.1; 10.7 and 11.4 MeV may be assigned to transitions to analogue states. (auth)

50593 INELASTIC DEUTERON SCATTERING FROM $1f_{\frac{7}{2}}$ NUCLEI. Hansen, Ole (Massachusetts Inst. of Tech., Cambridge. Univ., Copenhagen); Belote, T. A.; Dorenbusch, W. E. Nucl. Phys., A118: 41-64(1968).

The elastic and inelastic scattering of deuterons from $1f_{\frac{7}{2}}$ nuclei (^{40,42,44}Ca, ^{45}Sc, ^{46,48}Ti, ^{50,51}V, ^{50,52}Cr and ^{54}Fe) was measured at 7.50-MeV bombarding energy. The deuterons were detected in a multi-angle spectrograph in the angular interval from 22.5 to 157.5° with an energy resolution of 8 keV. The elastic scattering data were analyzed by the optical model, and the $0^+ \rightarrow 2_1^+$ and $0^+ \rightarrow 3^-$ transitions were analyzed by means of distorted-wave (DW) calculations. The angular distributions for transitions leading to 2_2^+, 4^+ and 0^+ states are discussed in terms of possible higher-order reaction mechanisms. (auth)

50594 GAMMA TRANSITIONS IN ^{37}Cl FROM BETA DECAY OF ^{37}S. Libert, J. (Centre de la Faculte Polytechnique, Mons, Belg.). Nucl. Phys., A118: 185-8(1968). (In French).

The energy of the gamma transition following the beta decay of ^{37}S was measured with a Ge(Li) detector. The 3105.3 ± 0.6 keV-transition is single and originates from the third level of ^{37}Cl. No other gamma rays were observed. (auth)

50595 (α,t) REACTION ON MEDIUM-WEIGHT ODD-MASS NUCLEI. I. ^{51}V AND ^{55}Mn. Matoba, Masaru (Kyoto Univ.). Nucl. Phys., A118: 207-24(1968).

The (α,t) reactions on ^{51}V and ^{55}Mn were studied at an incident alpha energy of 29.0 MeV using an E−ΔE semiconductor detector telescope. Angular distributions were obtained and analyzed by the DWBA theory. Zero-range DWBA calculations without radial cut-offs gave a reasonable fit to the data with depths of the real parts of the alpha and triton potentials of 183.7 and 149.0 MeV, respectively. The l-values and spectroscopic factors were deduced from the transitions leading to 15 low-lying states of ^{52}Cr and ^{56}Fe. The results are compared with the seniority scheme and the sum rule of the j-j coupling shell model and give information about the $(1f_{\frac{7}{2}})^n$ proton states in ^{52}Cr and ^{56}Fe. (auth)

50596 THE EXCITATION OF STRONG TRANSITIONS IN THE GIANT RESONANCE OF ^{12}C, ^{16}O, AND ^{28}Si BY INELASTIC ELECTRON SCATTERING. Drake, T. E.; Tomusiak, E. L.; Caplan, H. S. (Saskatchewan Accelerator Lab., Saskatoon, Can.). Nucl. Phys., A118: 138-50(1968).

The results of a search for magnetic quadrupole strength to the giant resonances of ^{12}C, ^{16}O and ^{28}Si using 140-MeV electrons are compared with the theoretical predictions of the shell model. The effects of altering the two-body residual interaction and the single-particle wave functions and the effects of including ground state correlations are calculated. The transition matrix elements for the strong magnetic dipole level in ^{28}Si at 11.4 MeV were calculated and these are compared with experiment. Measurements on strong electric dipole, magnetic dipole, and electric quadrupole levels in ^{16}O and ^{28}Si are presented and compared with the theoretical calculation of others. (auth)

50597 THE SPINS AND MAGNETIC DIPOLE MOMENTS OF ^{45}K AND ^{120}Sb. Garrett, Geoffrey Jeremiah. Princeton, N. J., Princeton Univ., 1968. 91p.

Thesis.

Spins and hyperfine structures were determined for 20-min ^{45}K and 16-min ^{120}Sb by the atomic beam magnetic resonance method. The experiments utilized the resonance apparatus which

is on line with the external beam of the Princeton cyclotron. The isotopes were produced by the reactions $^{48}Ca(p,\alpha)^{45}K$ and $^{120}Sn(p,n)^{120}Sb$ on isotopically enriched targets in an 0.3 μA beam of 17.5-MeV protons. The values of the spins and hyperfine structure constants are $I(^{45}K) = 3/2$, $I(^{120}Sb) = 1$, $|a(^{45}K)| = 102.2936(7)$ Mc/sec, $|a(^{120}Sb)| = 520(47)$ Mc/sec. From these values, the nuclear magnetic dipole moments are calculated to be $|\mu_I(^{45}K)| = 0.1734(10)$ nm and $|\mu_I(^{120}Sb)| = 2.34(22)$ nm (diamagnetically corrected). The measured moments are in good agreement with predictions based on the configuration $(1d_{\frac{3}{2}}^{1})_P$ $(1f_{\frac{7}{2}}^{2})_N$ for ^{45}K and the configuration $(2d_{\frac{3}{2}}^{1})_P$ $(2d_{\frac{3}{2}}^{1})_N$ for ^{120}Sb. (Disser. Abstr.)

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Refer also to abstracts 49099, 49110, 49162, 50522, 50542, 50549, 50559, 50560, 50565, 50572, 50583, 50584, 50592, 50597, 50665, 50671, and 50689.

50598 (LA–3527) NEUTRON CROSS SECTIONS FOR ^{235}U AND ^{238}U IN THE ENERGY RANGE 1 keV TO 14 MeV. Berlijn, J.-J. H.; Hunter, R. E.; Cremer, C. C. (Los Alamos Scientific Lab., N. Mex.). Aug. 1968. Contract W-7405-eng-36. 33p. Dep. CFSTI.

Recommended cross sections for ^{235}U and ^{238}U are presented. Comparisons of calculated and experimental values of integral systems were used as a guide in choosing the fits to microscopic cross-section data. (auth)

50599 (LA–3528) NEUTRON CROSS SECTIONS FOR ^{239}Pu AND ^{240}Pu IN THE ENERGY RANGE 1 keV TO 14 MeV. Hunter, R. E.; Berlijn, J.-J. H.; Cremer, C. C. (Los Alamos Scientific Lab., N. Mex.). July 1968. Contract W-7405-eng-36. 27p. Dep. CFSTI.

Recommended cross sections for ^{239}Pu and ^{240}Pu are presented. Comparisons of calculated and experimental values of integral systems were used as a guide in choosing the fits to microscopic cross-section data. (auth)

50600 (MIT–2098–479) INCONSTANCY OF MEAN RADII OF NUCLEAR STATES IN ROTATIONAL BANDS. Grodzins, Lee (Massachusetts Inst. of Tech., Cambridge. Lab. for Nuclear Science). Sept. 9, 1968. Contract AT(30-1)-2098. 37p. (CONF-680702–4). Dep. CFSTI.

From International Symposium on Nuclear Structure, Dubna, USSR.

The difference, $\Delta\langle R^2\rangle$, in the mean square radius of the first 2^+ state with respect to the 0^+ ground state of rotational bands has now been measured for a number of deformed nuclei using Moessbauer and muonic isomer shift techniques. The results of both types of measurements are reviewed. The derivation of $\Delta\langle R^2\rangle$ from Moessbauer data still contains up to 50% uncertainty in the evaluation of $|\Psi(0)|^2$. The muonic data are superfically more reliably analyzed. There are, however, large corrections for energy shifts resulting from asymmetries in the decay of the magnetically split nuclear transition. And there are further ambiguities in evaluating polarization effects. Considering the overall uncertainties, the results of the two techniques are in good accord. On the other hand the theoretical predictions of $\Delta\langle R^2\rangle$ are uniformly several times larger than the experimental values. Even more interesting is that recent experiments indicate that the mean radius of first 2^+ states become smaller than the mean radius of the respective ground state in the W–Os region. 55 references. (auth)

50601 (ORNL-TM–2272) PROMPT NEUTRON EMISSION IN THE MEDIUM-EXCITATION FISSION OF URANIUM. Burnett, S. C. (Oak Ridge National Lab., Tenn.). Oct. 1968. Contract W-7405-eng-26. 101p. Dep. CFSTI.

Thesis. Submitted to Univ. of Tennessee [Knoxville].

The energetics of the fission of ^{233}U induced by 8.5- and 13-MeV protons and of ^{238}U induced by 12-MeV protons were studied by means of a three-parameter experiment. The time-of-flight of one fragment was measured in coincidence with the pulse amplitudes produced by both fragments in Si surface-barrier detectors. The average number of neutrons emitted from the individual fragments and from both fragments together were obtained as functions of fragment mass and total kinetic energy. The number of neutrons emitted per fragment increased with increasing fragment mass and the "sawtooth" shape characteristic of neutron emission in low-excitation fission was apparent, although the relative depths of the minima in the present cases were reduced. The pre- and post-neutron-emission fragment mass distributions were obtained, together with the fragment energy distributions and mass vs energy correlations. The question of energy balance was studied by comparing the total energy available for fission into a given mass pair with the sum of the fragment excitation energies, calculated from neutron emission data and mass tables, and the measured fragment kinetic energies. In addition to experimental results, a discussion of errors and uncertainties in the energy-energy-time experiment is included. Problems such as dispersion effects and corrections for the effects of target thickness are discussed. (auth)

50602 (PPAR–5) 1029-keV LEVEL IN ^{200}Hg. Hopke, P. K.; Naumann, R. A.; Spejewski, E. H. (Princeton Univ., N. J.). Aug. 12, 1968. Contract AT(30-1)-2137. 10p. Dep. CFSTI.

A search for 1029-keV photons following the decay of ^{200}Tl was made. These were observed and led to an assignment of spin 2 to the 1029-keV level in ^{200}Hg. The relative intensity, I_{1029}/I_{661}, is 0.048 ± 0.003. (auth)

50603 RESONANCE INTEGRAL MEASUREMENT BY THE PILE OSCILLATOR METHOD. Latek, Stanislaw; Topa, Jerzy (Inst. of Nuclear Research, Swierk, Poland). Nukleonika, 13: 881-95(1968).

The infinitely diluted resonance integrals (1/v part excluded) of silver and tantalum were determined in the neutron spectrum of the zero-power reactor ANNA by the pile oscillator technique. The results are compared with the values calculated on the basis of the newest BNL cross-section data. (auth)

50604 GAMMA SPECTROSCOPIC RESEARCH WITH A 0.1 MW REACTOR. Giannini, M.; Nunberg, P.; Prosperi, D.; Sciuti, S. (CNEN, Rome). pp 779-86 of Fisica del Reattore. Rome, Consiglio Nazionale delle Ricerche, 1966. (In Italian).

From Conference on Physics of Reactors, Milan. See CONF-469.

Use of the RC-1 research reactor at Casaccia for capture gamma studies is described. A block diagram of the gamma spectrometer is shown; the gamma spectrum resulting from thermal neutron capture in ^{169}Tm is given. Results on internal electron conversion for $^{149}Sm(n,\gamma)$ are shown as a function of energy. Energy spectral data for odd-odd and even-odd nuclei are tabulated. Resonance absorption and scattering of gamma rays are discussed. (M.L.S.)

50605 ANALYSIS IN TERMS OF A GENERALIZED OPTICAL MODEL, OF THE CROSS SECTION OF ^{238}U IN THE ENERGY INTERVAL (0.05 TO 15) MeV. Baldoni, Bruna; Saruis, Anna Maria (CNEN, Bologna). pp 741-50 of Fisica del Reattore. Rome, Consiglio Nazionale delle Ricerche, 1966. (In Italian).

From Conference on Physics of Reactors, Milan. See CONF-469.

Use of a generalized optical model for analysis of the ^{238}U cross section is described. Differential cross sections are shown for E = 0.650 MeV, 1.1 MeV, 2.5 MeV, 4.1 MeV, 7.0 MeV, and 14.1 MeV. The equations used for the analysis are given. Total and differential inelastic cross sections are shown. Behavior of the Legendre polynomial expansion coefficient is determined as a function of energy. (M.L.S.)

50606 EVALUATION OF RADIATIVE CAPTURE CROSS SECTION OF FISSION PRODUCTS AT HIGH ENERGIES. Benzi, Valerio; Bortolani, Maria Vittoria (CNEN, Bologna). pp 751-7 of Fisica del Reattore. Rome, Consiglio Nazionale delle Ricerche, 1966. (In Italian).

From Conference on Physics of Reactors, Milan. See CONF-469.

The statistical model for determination of capture cross section is given. The statistical distribution of various energy levels of nuclei is determined. Application of the formulae is illustrated by considering ^{75}As as an example. Energy, spin, and parity for the ^{75}As are tabulated; cross-section calculations are compared with some measured values. (M.L.S.)

50607 ONE-NEUTRON TRANSFER REACTIONS IN EVEN AND ODD TIN ISOTOPES AND A REALISTIC NUCLEON–NUCLEON POTENTIAL. Alzetta, R. (Univ., Trieste, Italy); Sawicki, J. Phys. Rev., 173: 1185-92(Sept. 20, 1968).

Low-lying energy levels and wave functions of the even and odd isotopes of tin (A = 116–121) are calculated with 0-, 2-, and 4- and with 1- and 3-quasiparticle Tamm–Dancoff theories with Tabakin's realistic two-nucleon potential renormalized for core polarization by Gmitro et al. All the spectra are in good over-all agreement with experiment. The corresponding spectroscopic factors for the one-neutron stripping and pickup reactions are calculated and found to be in reasonable general agreement with the data of Schneid et al. and of Yagi et al. No adjustable parameters are involved in the theory (the single-particle input parameters are those of Bando). (auth)

50608 HIGH-RESOLUTION GAMMA-RAY SPECTROSCOPIC STUDY OF THE DECAY ^{133}Ba → ^{133}Cs. Donnelly, D. P.; Reidy, J. J.; Wiedenbeck, M. L. (Univ. of Michigan, Ann Arbor). Phys. Rev., 173: 1192-1201(Sept. 20, 1968).

The decay of ^{133}Ba to levels in ^{133}Cs was studied using Ge(Li) γ-ray spectrometers. The energies of the measured γ-ray transitions are 53.14(8), 160.68(10), 223.08(10), 276.45(8), 302.87(8), 355.99(7), and 383.92(7) keV. The corresponding relative γ-ray intensities of these transitions are 3.16(39), 0.99(10), 0.72(8), 11.62(82), 29.4(21), 100, and 14.3(10). γ-ray spectra in coincidence with the 53.1-, 79.6-, 81.0-, 276.4-, 302.9-, 356.0-, and 383.9-keV γ rays were obtained. The data are in quantitative agreement with the existing decay scheme. The K-shell internal-conversion coefficients were determined, using the present γ-ray relative intensities and published K-shell internal-conversion-electron relative intensities. These results and earlier lifetime measurements and mixing ratios were used to calculate γ-ray-transition retardation and enhancement factors. (auth)

50609 ISOMER RATIO OF ^{137m}Ce TO ^{137g}Ce PRODUCED IN SEVERAL CHARGED-PARTICLE REACTIONS. Kiefer, R. L.; Street, K. Jr. (Univ. of California, Berkeley). Phys. Rev., 173: 1202-(Sept. 20, 1968).

The ^{137m}Ce–^{137g}Ce isomer ratio was studied to obtain information on the effect of angular momentum in the de-excitation of a compound nucleus. The ratio of the formation cross section of the high-spin isomer to that of the low-spin isomer was measured as a function of energy for reactions induced by ^{3}He, ^{4}He, ^{7}Li, and ^{12}C. The ratio is seen to increase with increasing projectile energy and is shown to correspond to an increase in the average angular momentum. The isomer-ratio results are compared with calculations using the Huizenga–Vandenbosch theory. Using the nuclear temperature based on the Fermi-gas model and the spin cutoff factor calculated with 0.5 of the rigid-body moment of inertia, reasonable agreement was obtained with experimental results in all four reactions studied. (auth)

50610 ^{197}Au(n,γ)^{198}Au REACTION MECHANISM. Wasson, O. A.; Chrien, R. E.; Bhat, M. R.; Lone, M. A.; Beer, M. (Brookhaven National Lab., Upton, N. Y.). Phys. Rev., 173: 1170-84 (Sept. 20, 1968). (BNL-12343).

The variation in intensity of 24 γ rays emitted in neutron capture near the 4.9-eV resonance in gold was measured as a function of neutron energy. Significant interference was observed in the partial capture cross sections, which was consistent with interference between local resonances provided that a bound level was postulated which contributes 3.5 b to the thermal-capture cross section. With this assumption, no direct-reaction mechanism is required in the capture process. Capture γ-ray spectra were also observed in the various resonances for neutron energies <400 eV. Previously unreported γ rays were observed in thermal-neutron capture, while additional new γ rays were observed in resonance capture. The choice of relative signs of the partial-width amplitudes of the 4.9- and 60-eV resonances required to fit the data is inconsistent with the usual assumption of normally distributed width amplitudes. (auth)

50611 TOTAL INTERNAL-CONVERSION COEFFICIENTS FOR LOW-ENERGY E2 TRANSITIONS IN ^{224}Ra, ^{228}Th, ^{234}U, ^{236}U, AND ^{240}Pu. Duke, C. L.; Talbert, W. L. Jr. (Iowa State Univ., Ames). Phys. Rev., 173: 1125-32(Sept. 20, 1968). (IS–1779).

The total internal-conversion coefficients were measured for E2 transitions from first excited state to ground state in five heavy deformed nuclei. α-particle gating was used to determine the population of the first excited levels from parent decays. Photon spectra, as observed by a well-type NaI(Tl) detector in coincidence with the gating α particles, were analyzed to determine the ratio of γ transitions to total transitions. The α gating spectra and photon spectra were analyzed on a computer, when necessary, using a nonlinear least-squares curve-fitting program. The resulting coefficients are 19.6 ± 1.4 for the 84.4-keV transition in ^{224}Ra, 158 ± 7 for the 57.6-keV transition in ^{228}Th, 780 ± 55 for the 43.5-keV transition in ^{234}U, 607 ± 29 for the 45.28-keV transition in ^{236}U, and 845 ± 93 for the 42.88-keV transition in ^{240}Pu. The internal-conversion coefficient for the transition in ^{240}Pu is somewhat lower than the theoretical predictions of Hager and Seltzer and of Sliv and Band, whereas the internal-conversion coefficient for the transition in ^{234}U is somewhat higher. The internal-conversion coefficients for the remaining transitions agree with the theoretical values within the experimental uncertainties. (auth)

50612 NUCLEAR LEVELS IN ^{142}Pr. Kern, Jean (Univ., Fribourg, Switzerland. Florida State Univ., Tallahasee); Struble, Gordon L.; Sheline, Raymond K.; Jurney, E. T.; Koch, H. R.; Maier, B. P. K.; Gruber, U.; Schult, O. W. B. Phys. Rev., 173: 1133-58(Sept. 20, 1968). (LA-DC-9504).

A combination of (d,p)-reaction spectroscopy and high- and low-energy γ rays following thermal-neutron capture in ^{141}Pr was used to study the levels in ^{142}Pr. The (d,p) reaction populates 65 states below 2 MeV, whereas 37 states below 2 MeV are populated by high-energy γ transitions from thermal-neutron capture. The ground-state Q-value determined in the (d,p) reaction is 3622 ± 3 keV, in agreement with the neutron binding energy of 5843.4 ± 1.5 keV. Differential cross sections were measured at nine angles for the (d,p) reaction and interpreted in terms of the distorted-wave Born-approximation reaction theory. Utilizing, in addition, some of the low-energy γ rays observed with a bent-crystal spectrograph and with a Ge(Li) spectrometer, it was possible to make the following assignments (energy in keV, spin and parity in parentheses): ground state, (2−); 3.683, (5−); 17.740, (3−); 63.746, (6−); 72.294, (4−); 84.998, (1−); 128.251, (5−); 144.587, (4−); 176.863, (3−); and 200.525, (2−). These states are interpreted in terms of configuration mixing between the two configurations $\pi d_{\frac{5}{2}}{}^{1}\nu f_{\frac{7}{2}}{}^{1}$ and $\pi g_{\frac{7}{2}}{}^{-1}\nu f_{\frac{7}{2}}{}^{1}$. Not only the energies of the levels but also the transition probability ratios are consistent with this interpretation. The calculated half-life of the 3.683 keV, 5− isomeric state is in reasonable agreement with the experimental value. Tentative spin and parity assignments were made to levels above 250 keV. (auth)

50613 CUMULATIVE FISSION YIELD AND HALF-LIFE OF ^{134}Sb. Delucchi, A. A.; Greendale, A. E.; Strom, P. O. (Naval Radiological Defense Lab., San Francisco). Phys. Rev., 173: 1159-64(Sept. 20(1968).

The cumulative fission yield of ^{134}Sb produced in thermal neutron-induced fission of ^{235}U was experimentally determined, and the half-life of the nuclide was measured. The cumulative fission yield and half-life were found to be 0.32 ± 0.04% and 11.1 ± 0.8 sec, respectively. It is shown that the fission yields presently measured in the mass-134 chain do not fit a Gaussian isobaric yield curve and that this could be accounted for by isomerism in ^{134}Sb. A nuclear level scheme for ^{134}Sb which predicts two isomeric states for this nuclide is presented. From the experimental data, an upper limit of approximately 2 sec is determined for the half-life of the proposed isomer. (auth)

50614 SUCCESS AND LIMITATIONS OF TWO- AND FOUR-QUASIPARTICLE TAMM–DANCOFF THEORIES OF VIBRATIONAL STATES: APPLICATIONS TO EVEN TIN ISOTOPES WITH A REALISTIC NUCLEON-NUCLEON POTENTIAL. Gmitro, M. (International Atomic Energy Agency, Trieste, Italy); Rimini, A.; Sawicki, J.; Weber, T. Phys. Rev., 173: 964-71(Sept. 20, 1968).

Extensive calculations of the spectra of the even Sn isotopes with the two- and four-quasiparticle (qp) Tamm-Dancoff theories are performed. The effective nuclear forces are the Tabakin and the Yale-Shakin potentials renormalized for core polarization involving up to all the subshells between the magic numbers 8 and 126. Several different sets of single-particle energies are considered, one of which corresponds to a Woods-Saxon potential. Over-all semiquantitative agreement with the data is obtained. It is shown how relative large values of the quadrupole moment of the 2_1^+ state [such as $Q(2_1^+) = +0.125$ b] may arise from large two-qp-four-qp cross terms even in cases where four-qp components are small. Many aspects of the theory are critically examined; in particular, several different approximations in projecting out spurious kets of the nucleon-number nonconservation. Projected improvements and developments of the theory are outlined. (auth)

50615 LIFETIME MEASUREMENTS IN ^{156}Sm DECAY. Andrejtscheff, W.; Meiling, W. (Zentralinstitut fuer Kernforschung, Rossendorf, Ger.). Phys. Lett., 27B: 502-3(Sept. 16, 1968). (In German).

In ^{156}Sm decay, the lifetimes of the excited states at 291 keV and 88 keV of ^{156}Eu were determined to be $T_{\frac{1}{2}}$ (291 keV) ≤ 0.2 ns and $T_{\frac{1}{2}}$ (88 keV) = 12.0 ± 0.3 ns. (auth)

50616 A HIGH-RESOLUTION γ-RAY SPECTROSCOPIC STUDY OF THE DECAYS ^{133}Ba → ^{133}Cs AND ^{77}Ge → ^{77}As. Donnelly, Denis Philip. Ann Arbor, Mich., Univ. of Michigan, 1967. 108p.

A study was made of gamma radiation following the decays of ^{133}Ba and ^{77}Ge. All the measurements were made using Ge(Li) spectrometers, with the exception of a few energy measurements which were made using the University of Michigan 2m curved-crystal-spectrometer. In ^{133}Ba, energy and relative intensity measurements were made on seven gamma-rays; gamma-gamma coincidence measurements were made gating on the 383.9, 356.0, 302.9, 276.4, 81.0, 79.6, and 53.1 keV gamma-rays. The measurements quantitatively support the existing decay scheme. K conversion coefficients were calculated by using the present gamma-ray relative intensities and published K internal conversion electron

intensities. A review of spin assignments to levels in ^{133}Cs was made. Most of the data are in agreement with the spin sequence, $\frac{7}{2}$, $\frac{5}{2}$, $\frac{5}{2}$, $\frac{3}{2}$, and $\frac{1}{2}$, in the order of increasing energy from the ground state. Transition rates were compared with the Weisskopf single-particle estimates. In ^{77}Ge, energy and relative intensity measurements were made on 81 gamma-rays; seven of these energies were measured using a 2 m curved-crystal-spectrometer. A level scheme was constructed which includes 25 excited levels and 72 transitions. The levels were categorized according to the number and strength of transitions feeding and depopulating them. (Diss. Abstr.)

50617 AVERAGED RESONANCE NEUTRON CAPTURE IN GOLD. Allen, B. J.; Bird, J. R. (Australian Atomic Energy Commission, Lucas Heights). Phys. Lett., 27B: 494-6(Sept. 16, 1968).

The intensities of resonance averaged γ rays from the capture of 10- to 60-keV neutrons in gold were measured with a Ge(Li) detector. Transition strengths to final states between 0.2 and 1.2 MeV have strong E1 reduced widths and provide evidence for a significant 4s−3p direct component in the capture mechanism. (auth)

50618 SPINS AND NUCLEAR MOMENTS OF ^{116}Sb, ^{117}Sb, ^{118}Sb, ^{119}Sb, AND ^{120}Sb. Jackson, A. D. Jr.; Rogers, E. H. Jr.; Garrett, G. J. (Princeton Univ., N. J.). Phys. Rev., 175: 65-76(Nov. 5, 1968). (PUC-937-288).

The spins and hyperfine structures of several antimony isotopes were measured by atomic-beam magnetic-resonance methods. The isotopes were produced by proton bombardment of isotopically-enriched tin in the Princeton cyclotron. The experiment on ^{119}Sb gives g (Sb) = −1.970 60(6). The magnetic moments of these and other antimony isotopes are discussed in terms of configuration-mixing calculations using matrix elements of the Hamada-Johnston potential. (auth)

50619 METHOD FOR DETECTING VERY WEAK PHOTOGRAPHICALLY RECORDED SPECTRAL LINES. AN INTENSITY RULE FOR THE AUGER ELECTRON TRANSITIONS AND K AUGER ELECTRON SPECTRUM THORON. Slaetis, Hilding (Research Inst. for Atomic Physics, Stockholm). Ark. Fys., 37: 25-36(1968).

A rule is proposed for the Auger electron transitions that seemed to be valid for the L Auger electrons found in the beta-ray spectrum of the active deposit of thoron. In order to test this rule for the K Auger electrons in the quoted spectrum, it was necessary to detect more Auger lines than were seen before. A method was found in which an earlier exposed film, in which only 12 K Auger lines were observed, now over 50 K Auger lines were detected and interpreted. Thus it was possible to see the KLL lines not only for Bi, but also for all the other elements in the decay of thoron, e.g., Tl, Pb, and Po. Bismuth, KLN, KMM, KMN, and KNN Auger electrons were measured. (Sweden)

50620 EXPERIMENTAL DETERMINATION OF THE AMOUNT OF FAST NEUTRONS IN THE FISSION SPECTRUM. Nasyrov, F.; Stsiborskii, B. D. Dokl. Akad. Nauk SSSR, 180: 836-8(June 1, 1968). (In Russian).

If a small amount of moderator is contained in the reactor core, the reactor neutron spectrum may be used to study the spectral properties of fission neutrons. This problem was investigated within the core of a fast reactor operating with highly enriched ^{235}U; the core also contained 20% Fe, 10% Mo, and 10% ^{238}U. The neutron spectra were investigated in the 0.6 to 24 MeV region by means of threshold detectors. Fission chamber determinations and activation studies were also made. It was found that below 3 MeV, the reactor spectrum differs from the fission spectrum; this is due to the low energy transitions of neutrons caused by inelastic processes. Above 3 MeV, the spectra are fairly similar. The evaporation model characterizes the fission neutron spectrum up to 24 MeV; it remains to be determined how far this range extends. (TTT)

50621 MUONIC ISOMER SHIFT MEASUREMENTS IN Sm, W, AND Os ISOTOPES AND THEIR INTERPRETATION IN TERMS OF CHANGES IN NUCLEAR CHARGE DISTRIBUTION. Baader, R.; Backe, H.; Engfer, R.; Hesse, K.; Kankeleit, E.; Schroeder, U.; Walter, H. K.; Wien, K. (Technische Hochschule, Darmstadt, Ger.). Phys. Lett., 27B: 425-7(Sept. 2, 1968).

Muonic isomer shifts have been observed in ^{152}Sm, ^{182}W, ^{184}W, ^{186}W, ^{188}Os, ^{190}Os and ^{192}Os. After the correction of these data for hyperfine effects, a combined analysis with Moessbauer isomer shift data allows determination of two parameters describing the change of the charge distribution in excited nuclei. (auth)

50622 MEASUREMENT OF THE MAGNETIC HYPERFINE SPLITTING OF NUCLEAR γ RAYS IN MUONIC THALLIUM. Baader, R.; Backe, H.; Engfer, R.; Kankeleit, E.; Schroeder, W. U.; Walter, H.; Wien, K. (Technische Hochschule, Darmstadt, Ger.). Phys. Lett., 27B: 428-30(Sept. 2, 1968).

A well-resolved magnetic hyperfine splitting of nuclear γ rays was observed in muonic ^{203}Tl and ^{205}Tl. The ground-state splittings are 2.66 ± 0.30 and 2.32 ± 0.06 keV, respectively. The hfs is explained by a magnetization distribution calculated by shell-model configurations. (auth)

50623 INTERNAL CONVERSION COEFFICIENTS OF HIGH-ENERGY GAMMA RAYS. Moragues, J. A.; Gelletly, W.; Mariscotti, M. A. J. (Brookhaven National Lab., Upton, N. Y.). Phys. Lett., 27B: 441-2(Sept. 2, 1968).

The K conversion coefficients of transitions of 1- to 9-MeV in ^{114}Cd were determined by combining measured relative intensities of the γ rays with the conversion-electron data of Von Egidy and Kaiser. These coefficients disagree with those reported by Smither, but agree with recent theoretical estimates. (auth)

50624 NORMALISATION OF THE (t,d) REACTION. Jeans, A. F.; Jones, K. N.; Darcey, W. (Oxford Univ.). Phys. Lett., 27B: 431-3(Sept. 2, 1968).

From a study of the ^{208}Pb(t,d)^{209}Pb reaction at E_t = 8.85 MeV, the coefficient required to normalize the zero-range DWBA cross section for the (t,d) reaction is determined to be $5.60 \pm 0.65 \times 10^4$ MeV^{2}fm^3. (auth)

50625 AUTOCORRELATION EFFECTS IN THE NEUTRON INDUCED FISSION CROSS SECTION OF ^{235}U. Cao, M. G.; Migneco, E.; Theobald, J. P. (EURATOM, Geel, Belg.). Phys. Lett., 27B: 409-10(Sept. 2, 1968).

A periodical autocorrelation effect in the neutron induced fission cross section of ^{235}U is reported and interpreted on the basis of the existence of intermediate states in the fission exit channels. (auth)

50626 CONVERSION ELECTRON SPECTRA: A LINE SHAPE ANALYSIS FOR PERMANENT MAGNET SPECTROGRAPHS. Diethrich, Cecil Gerald. Ann Arbor, Mich., Univ. of Michigan, 1967. 122p.

Thesis.

The first goal of this study was an understanding of the factors which determine the shape of spectral lines produced in permanent magnet beta spectrographs. Computer programs were written to provide a complete three-dimensional solution involving none of the approximations of earlier line shape studies, and a CRT display was used for a thorough examination of a wide range of effects. The result is a detailed knowledge of exactly how theoretical line shapes are affected by variations in the spectrograph parameters. Information obtained from the line shape study was next applied in redesigning the spectrograph camera. A rarely used configuration was adopted on the basis of the previous analysis. Local corrections of the three existing permanent magnets were made to ensure field uniformity to better than 0.1%. New source preparation techniques were also investigated. Narrow ribbons of sulfonated polystyrene were used as source backings with good results. The problem of electrostatic retardation by nonconducting source layers and backings was studied briefly. The redesigned spectrograph was used for a study of the internal conversion lines in the decay of ^{109}Cd after a curved-crystal spectrometer measurement of the γ-transition energy. The latter was determined to be E_γ = 88.035 ± 0.006 keV. Partial resolving of the L-subshell lines in the conversion electron spectrum was achieved and ratios favoring the accepted E3 multipolarity were obtained: K : L : M : N = 118 ± 3 : 100 : 20.8 ± 1.5 : 5 ± 1 and $L_1 : L_2 : L_3$ = 24.6 ± 3.8 : 100 : 97.8 ± 9.5. A comparison was made with values from the tables of Sliv and Band and of Rose, and the more recent theoretical calculations of Hager and Seltzer. (Disser. Abstr.)

50627 EXCITATION OF SINGLE NEUTRON HOLE STATES IN ^{207}Pb BY INELASTIC PROTON SCATTERING AT 20.2 MeV. Glashausser, C.; Harvey, B. G.; Hendrie, D. L.; Mahoney, J.; McClatchie, E. A.; Saudinos, J. (Univ. of California, Berkeley). Phys. Rev. Lett., 21: 918-21(Sept. 23, 1968).

Differential cross sections for the excitation of the 0.570-, 0.894-, 1.633-, 2.33-, and 2.74-MeV states in ^{207}Pb were measured in inelastic proton scattering at 20.2 MeV. Analysis via the microscopic model indicates that core polarization is important in describing these presumed single-particle transitions. (auth)

50628 HIGH ENERGY LEVELS OF ^{144}Nd EXCITED IN THE DECAY OF ^{144}Pm. Barrette, J. (Univ. of Montreal); Monaro, S.; Santhanam, S.; Markiza, S. Can. J. Phys., 46: 2189-92(Oct. 1, 1968).

Gamma-gamma coincidence measurements, carried out with a 7.6 cm × 7.6 cm NaI(Tl) crystal and a 30 cm^3 Ge-Li detector, were performed to look for excited states in ^{144}Nd higher than the known level at 1789 keV. These measurements definitely estab-

lish the existence of a level at 2093.11 keV and suggest the placing of another level at 2204.74 keV. Furthermore, an E3 transition deexciting the 1510.14-keV level seems to be present. (auth) (CANADA)

50629 THE DECAY OF ^{144}Pm. Santhanam, S. (Loyola Coll., Montreal). Can. J. Phys., 46: 2181-8(Oct. 1, 1968).

In the electron-capture decay of ^{144}Pm prepared by (p,2n) reaction on enriched ^{145}Nd, it is shown that, in addition to the well-known energy levels at 696, 1313, and 1789 keV, two new levels exist, one at 2093 keV, and another at 1509 keV. The state at 2093 keV de-excites with the emission of a 304-keV gamma ray to the 6^+ level at 1789 keV, and by a crossover transition to the 4^+ level at 1313 keV with the emission of a 780-keV gamma ray. The level at 1509 keV leads to the first excited state (2^+) at 696 keV with the emission of a gamma ray of energy 813 keV. The intensities of the 780-, 304-, and 813-keV gamma rays are, respectively, 1.5, ≈0.1, and 0.5% of that of the 696-keV gamma ray. (auth) (CANADA)

50630 ELASTIC SCATTERING OF 4.56-MeV NEUTRONS ON LEAD FROM 10 TO 40°. Tripard, G. E.; Martin, P. W.; White, B. L. (Univ. of British Columbia, Vancouver). Can. J. Phys., 46: 1883-6(Sept. 1, 1968).

The differential elastic scattering cross section for 4.56-MeV neutrons on natural lead was measured for angles at 5° intervals between 10 and 40°. The results were corrected for absorption and multiple scattering and are compared with other recent measurements using different techniques at similar neutron energies. (auth) (CANADA)

50631 PERTURBED 208.00-59.54 keV γ-γ ANGULAR CORRELATION IN ^{237}Np. Hrynkiewicz, A. Z. (Inst. for Nuclear Physics, Krakow); Ogaza, S.; Styczen, J.; Hrastnik, B.; Basar, I. Fizika (Zagreb), 1: 47-55(July 1, 1968).

The perturbed directional γ-γ angular correlation was measured in ^{237}Np. The static hyperfine coupling between the nuclear magnetic moment and the angular momentum of the electronic states was found to be present both in the liquid source and in the polycrystallinic source. The spin sequence for the 208.00 — 59.54 → 0 keV transition was confirmed to be $\frac{3}{2}$, $\frac{5}{2}$, $\frac{5}{2}$ with the mixing ratio $\delta = +0.145$ for the E2 admixture in the preferably M1 transition. The agreement between directional correlation and internal conversion data was shown to be fairly good. The angular momentum J of the electronic states was determined for both sources: for the polycrystallinic source the J = 1 value gives the attenuation factor $G_{22}(t)_{J=1}$ in good agreement with the experimental results, while for the liquid source, the best J value was shown to be J = $\frac{3}{2}$. The J-dependent hyperfine structure constant a was determined for the polycrystalline source to be as $a/\hbar$ = 83 ± 3 MHz and for the liquid source to be $a/\hbar$ = 44 ± 2 MHz. The average magnetic field at the site of ^{237}Np nuclei was deduced for the polycrystallinic source $H(0)_{J=1}$ = 54 ± 14 kOe and for the liquid source $H(0)_{J=\frac{3}{2}}$ = 42 ± 12 kOe. (auth)

50632 EXPERIMENTAL INVESTIGATION OF THE VIBRATIONAL LEVELS AND TWO-QUASI-PARTICLE LEVELS IN ^{172}Yb. Wien, Karl (Technische Hochschule, Darmstadt, Ger.). Z. Phys., 216: 1-27(1968). (In German).

In the decay of ^{172}Tm to ^{172}Yb β^-,e^- and γ-radiations were detected using scintillation counters and lithium drifted Ge- and Si-detectors. With various coincidence methods excited levels in ^{172}Yb above 1 MeV were found at 1042.9(0^+), 1118.2(2^+), 1155.2(1^-), 1172.5(3^+), (1198.5), 1263.0(4^+), 1466.0(2^+), 1476.8(2^+), 1549.2(3^+), 1608.4(2^+), 1662.7(3^+) and 1700.7(3^+) keV. From the γ-decay to the rotational groundstate levels Z-Parameters were obtained. These results are discussed together with theoretical calculations in the frame of Rotation-Vibrationmodel and the microscopic superfluid. model. (auth)

50633 THE DECAY OF A NEW 18.7-hr ISOMER OF ^{200}Au. Sakai, Kojiro; Daly, P. J. (Purdue Univ., Lafayette, Ind.). Nucl. Phys., A118: 361-8(1968).

An 18.7 ± 0.5 h isomer of ^{200}Au was found as a result of bombardments of enriched ^{198}Pt with 35-MeV α particles and of enriched ^{202}Hg with 20-MeV deuterons. The following intense γ rays were observed in the decay of ^{200m}Au (relative intensities in parentheses): 181.1 ± 0.4 (73), 255.8 ± 0.3 (96), 367.8 ± 0.3 (100), 498.2 ± 0.4 (95), 579.6 ± 0.4 (100), 759.6 ± 0.4 (90) and 904.5 ± 0.6 keV (11). By the sum-coincidence technique, it was shown that the six strongest γ rays are in prompt coincidence with each other. It is proposed that in the decay of ^{200m}Au, the main β^- decay branch populates a level in ^{200}Hg at 2642 keV, which de-excites by a cascade of four γ rays to the known 4^+ level at 947.3 keV. Isomeric transitions to the ^{200}Au ground state account for less than 4% of the ^{200m}Au decays. (auth)

50634 FISSION COMPONENTS IN ^{234}U RESONANCES. James, G. D.; Rae, E. R. (Atomic Energy Research Establishment, Harwell, Eng.). Nucl. Phys., A118: 313-20(1968).

The fission cross section of ^{234}U was measured in the energy range below 20 keV and shows three regions of strong fission yield with essentially no fission at the intervening energies. In the first group, which covers the energy range up to 740 eV, all the 20 resonances known to exist below 370 eV in the total cross section have a measurable fission width with an average $\langle\Gamma_f\rangle \approx$ 0.098 MeV. The second and third groups are centered at 8.33 keV and 13.9 keV and extend over about 1 keV. The area under the fission cross section curve $\sigma_0\Gamma_f$ is 97.7b · eV for the 29 resonances below 740 eV, 52 b · eV for the group at 8.33 keV and 32 b · eV for the group at 13.9 keV. An analysis of the distribution of fission widths for the 20 resonances below 370 eV shows that they fit a χ^2 distribution with ν = 1.39 ± 0.37 degrees of freedom. This evidence for a grouping of sub-threshold fission resonances is similar to that already found in ^{240}Pu and ^{237}Np and according to Weigmann and Lynn is a result of the existence of the second minimum in the fission potential barrier as predicted by Strutinsky. The well depth corresponding to a level density of 7 keV indicates that the second minimum lies at 3 MeV above the ground state of ^{234}U. (auth)

50635 ENERGY LEVELS IN ^{234}U POPULATED IN THE β DECAY OF ^{234}Pa(UZ). Bjoernholm, S. (Univ. of Copenhagen); Borggren, J.; Davies, D.; Hansen, N. J. S.; Pedersen, J.; Nielsen, H. L. Nucl. Phys., A118: 261-301(1968).

Intense sources of the 6.7-h ^{234}Pa isomer UZ were investigated with Ge(Li) counters, a high-resolution 180° beta-ray spectrograph and with coincidence techniques. The Ge(Li)γ spectrum of the 33-μs isomer of ^{234}U was recorded by means of delayed coincidences. A total of 130 transitions in ^{234}U was observed. The decay scheme includes the following levels, denoted by energy in keV and quantum number K^π for the rotational band heads only; 787(01^-), 810(00^+), 927(22^+), 990(22^-), 1127(22^+), 1421(66^-), 1496(33^+), 1552(55^+), (1693)((55^-)), 1723(33^-) and 1723(44^+). The majority of the levels were identified in stripping and pick-up experiments. The intrinsic states correspond to theoretically predicted two-quasiparticle states and collective quadrupole and octupole excitations. Appreciable mixing of some of the two-quasiparticle configurations occurs and influences the decay pattern in a major way. Unexpectedly, there exists a $K^\pi = 2^+$ configuration with the energy 1127 keV in addition to the 2^+ collective state at 927 keV. This level decays by strong transitions to the 2^+ state at 927 keV and the 0^+ state at 810 keV and only by weak transitions to the 0^+ ground state. (auth)

50636 ENERGY LEVELS IN ^{234}U POPULATED BY THE ^{233}U (d,p) AND ^{235}U(d,t) PROCESSES. Bjoernholm, S.; Dubois, J.; Elbek, B. (Univ. of Copenhagen). Nucl. Phys., A118: 241-60 (1968).

Enriched targets of ^{233}U and ^{235}U were irradiated with 13-MeV deuterons, and proton and triton spectra from the neutron-transfer processes were recorded by a broad-range single-gap magnetic spectrograph with an over-all energy resolution of 0.1%. The results were compared with level schemes obtained in decay studies and analyzed in terms of the Satchler stripping theory and Nilsson wave functions. The (d,t) reactions on the ^{235}U target allowed the identification of two-quasiparticle components involving the $\frac{7}{2}^-$[743] neutron plus a neutron-hole state. The following assignments and band head energies were obtained: $K^\pi = 0^+$, 0 keV; $K^\pi = 2^-$, 990 keV; $K^\pi = 6^-$, 1421 keV; $K^\pi = 1^-$, 1434 keV; $K^\pi = 5^-$, 1693 keV; $K^\pi = 4^+$, 1884 keV and $K^\pi = 3^+$, 1956 keV. Similarly, the (d,p) reactions on the ^{233}U target identified two-quasiparticle components involving the $\frac{5}{2}^+$[633] neutron plus a neutron particle state: $K^\pi = 0^+$, 0 keV; $K^\pi = 2^+$, 927 keV; $K^\pi = 2^+$, 1127 keV; $K^\pi = 3^+$, 1496 keV and $K^\pi = 5^+$, 1552 keV. (auth)

50637 DECAY OF ^{164}Tb. Monnand, E.; Moussa, A. (CEN, Grenoble, France). J. Phys. (Paris), 29: 545-9(July 1968). (In French).

The decay of ^{164}Tb, produced in the reaction ^{164}Dy(n,p)^{164}Tb with 14-MeV neutrons, was studied using β and γ spectrometry. The endpoint energy of the β spectrum and the half-life of ^{164}Tb were measured to be 3.1 ± 0.1 MeV and 3.2 ± 0.2 min, respectively. A decay scheme for ^{164}Tb is proposed. (D.C.W.)

50638 NEW TRANSITIONS OF EVEN TIN ISOTOPES 120, 118, 116, AND 114 OF ODD-ODD ^{116}Sb. Rahmouni, O. (Institut de Physique Nucleaire, Orsay, France). J. Phys. (Paris), 29: 550-62(July 1968). (In French).

A spectroscopic study of the even Sn isotopes with A = 114, 116, 118, and 120 from the decay of Sb and Te isotopes was performed using Ge(Li) detectors. The γ energies and relative intensities are given. Some previously unreported transitions were observed. Some 0^+ levels that had previously been identified in ^{118}Sn and

^{120}Sn only through nuclear reactions were established. In addition, some γ rays were attributed to transitions in ^{116}Sb. (D.C.W.)

50639 NUCLEAR REACTIONS INDUCED BY HEAVY IONS: STUDY OF MECHANISM OF DE-EXCITATION OF FISSILE COMPOUND NUCLEI AND TREATMENT OF HIGH ANGULAR MOMENTUM. Bimbot, Rene; Lefort, Marc; Simon, Annette (Facultes des Sciences de Paris, Orsay, France). J. Phys. (Paris), 29: 563-78(July 1968). (In French).

Excitation functions were measured for nuclear reactions induced by ^{12}C heavy ions on ^{197}Au. First, the total cross section for the formation of a compound nucleus at various energies between 60 and 90 MeV was obtained by summing all cross sections (^{12}C,xn) for all possible values of x (3 to 6) and by adding the fission cross section. This cross section was found to be higher by 30% than the total cross section computed by Thomas. It was shown that the gap can be well explained by grazing reactions between the heavy projectile and the target nucleus, the amount of which yields about 300 mb for 87-MeV ions. Therefore, nuclear interactions in which high values of angular momenta are involved do not pass through a compound nucleus process. Secondly, the effect of the angular momentum on compound nucleus de-excitation by neutron evaporation was considered by the classical method of the shift towards high energies of excitation functions (^{12}C,xn). It was found that, contrary to the case of similar experiments carried out on lighter nuclei (Zn, Dy), there was no shifting. This was attributed to two reasons: at the same angular momenta, the rotational energy is less for heavy nuclei than for medium or light ones; and astatine nuclides exhibit a rather large fission probability. It is known that many of the compound nuclei which are formed with large angular momenta will undergo fission preferentially, and the de-excitation by neutron evaporation occurs mainly for low angular momenta. The results are therefore very close to the data obtained with incident protons or alpha particles which usually do not have a very high angular momentum. (auth)

50640 INTERNAL CONVERSION ELECTRON SPECTRUM IN ^{176}Lu(n,γ)^{177}Lu REACTION. Beitin, M. R.; Kramer, N. D.; Prokof'ev, P. T. Latv. PSR Zinat. Akad. Vestis, Fiz. Teh. Zinat. Ser., No. 3, 3-7(1968). (In Russian).

The internal conversion electron spectrum in the reaction was investigated using a β spectrograph with a resolution of 0.1 to 0.3%. About 200 conversion electron lines were measured in the energy interval 200 to 2200 keV. 148 γ transitions, among them 87 new transitions, were obtained. M1 and E2 multipolarities were determined for the γ transitions in the energy interval 200 to 900 keV. (auth)

50641 LOW-ENERGY TRANSITIONS AND STATES OF ODD-ODD NUCLEI EXCITED BY RADIATIVE NEUTRON CAPTURE. Cristu, M. I. (Inst. of Atomic Physics, Bucharest). Stud. Cercet. Fiz., 20: 577-635(1968). (In Rumanian).

Single and coincidence γ-ray spectra from thermal neutron capture in iodine and arsenic nuclei yielded valuable information about low-energy level schemes and transitions of the ^{128}I and ^{76}As nuclei. Lack of agreement between previously reported data on ^{128}I are attributed to inconsistencies in the methods used and lack of precise calculations. Only the 163-keV and possibly the 27-keV states may be attributed to multiplets of the ground states of ^{76}As and ^{128}I; transitions to the ground states from other low-energy states must be considered as transitions between different multiplets. The complex nature of the spectrum and the low intensity of the cascades render the measurement of angular correlations between γ rays from neutron capture unsuitable for the determination of the level parameters; determination of the angular correlations of protons from the (d,p) reaction appears to be preferable for these nuclei. It is recommended that the single-particle transitions of the adjacent ^{129}Xe and ^{77}Se nuclei can also be identified by analyzing the high-energy transitions of γ spectra, in order to obtain additional information about the low-level transitions of ^{128}I and ^{76}As. 73 references. (TTT)

50642 (n,3n) PROCESSES AND THE STATISTICAL THEORY. Liskien, H. (EURATOM, Geel, Belgium). Nucl. Phys., A118: 379-88(1968).

The statistical concept of the compound nucleus model was expanded to successive emission of three particles after compound nucleus formation. Application to (n,3n) reactions leads to a cross-section formula which corresponds to the well-known Weisskopf formula for (n,2n) cross sections. Experimental (n,3n) cross sections were determined for some odd-proton target nuclei in the mass region $100 < A < 150$ for neutrons between 18.2 and 19.5 MeV and compared with the prediction of the statistical model. (auth)

50643 GAMMA RAYS FROM INELASTIC SCATTERING OF 2.9-MeV NEUTRONS BY ^{55}Mn, ^{59}Co, ^{63}Cu, ^{65}Cu, ^{139}La, AND ^{141}Pr. Daniels, J. M.; Felsteiner, J. (Univ. of Toronto). Can. J. Phys., 46: 1849-66(Sept. 1, 1968).

Gamma rays produced by inelastic scattering of 2.9-MeV neutrons on ^{55}Mn, ^{59}Co, ^{63}Cu, ^{65}Cu, ^{139}La, and ^{141}Pr were observed, using a lithium-drifted germanium detector. Coincidences between these gamma rays were observed, using a sodium iodide detector and a lithium-drifted germanium detector. It was possible to resolve gamma rays, hitherto unresolved, to determine their energies to within ±1 keV in most cases, and to determine their relative intensities to within ±30%. From the energies of the gamma rays and the knowledge of which gamma rays are in coincidence, level diagrams were constructed for these nuclei. There was no reason to dispute the presently accepted level scheme for ^{55}Mn, ^{59}Co, ^{63}Cu, and ^{65}Cu, but the energies of the known levels were determined with greater precision. Two new levels, at 1685 and 1715 keV, are proposed for ^{139}La, and four new levels, at 1117, 1350, 1437, and 1451 keV, are proposed for ^{141}Pr. The decay of ^{141}Nd to ^{141}Pr was examined, and the previously published decay scheme was confirmed. In addition, another weak K-capture branch, to a level at 1437 keV, was found. No evidence is seen for the previously suggested levels at 880 keV in ^{141}Pr and at 800 keV in ^{139}La. The relative production rates of the excited states of all these nuclei were fitted to the Hauser–Feshbach model of inelastic neutron scattering. The earlier determinations of the spins of the first four excited states of ^{55}Mn are confirmed and a spin of $^{9}/_{2}$ is suggested for the level at 1883 keV. Spins are suggested for all the levels of ^{59}Co, up to and including the level at 1745 keV. These differ from all the three previously published spin determinations. The spin assignments previously published for the first three excited states of ^{63}Cu and ^{65}Cu are confirmed and spins are suggested for the next three excited states. For both ^{139}La and ^{141}Pr, only the spins of the ground state and the first excited state were known; in each case spins are suggested for the next six excited states. (auth) (CANADA)

50644 EVIDENCE FOR A 130-ns ISOMERIC STATE IN ^{198}Au. Bonitz, M. (Zentralinstitut fuer Kernforschung, Rossendorf, Ger. Univ. of Copenhagen). Nucl. Phys., A118: 478-80(1968).

By using delayed coincidence techniques applied to protons and γ rays emitted in the ^{197}Au(d,p)^{198}Au reaction, evidence was found for the existence of a 130-ns isomeric state in ^{198}Au. (auth)

50645 DECAY OF 24-min ^{146}Pr. Daniels, W. R.; Lawrence, F. O.; Hoffman, D. C. (Los Alamos Scientific Lab., N. Mex.). Nucl. Phys., A118: 467-77(1968).

The radiations associated with the β decay of 24 min ^{146}Pr were studied with Ge(Li), Si(Li), NaI(Tl) and trans-stilbene detectors. Gamma-gamma and gamma-beta coincidence experiments were performed, and gamma-gamma directional correlations were measured for the 1.525-0.454 MeV cascade. The observation of a 3.6 MeV β-group in coincidence with the 0.454 MeV photopeak establishes the total β-disintegration energy of ^{146}Pr as 4.1 ± 0.1 MeV. The β-ray spectrum is complex with an end-point energy of 4.1 ± 0.2 MeV. The intensity of the 0.454-MeV γ transition per β disintegration was found to be 0.49, and the intensities of some 40 other γ rays were determined. Most of these γ transitions were placed in the ^{146}Nd level scheme which includes excited states with energies as high as 3.819 MeV. The present data appear to be consistent with an assignment of either 1^- or 2^- for the ground state of ^{146}Pr. (auth)

50646 ANGULAR DISTRIBUTIONS OF FRAGMENTS FROM ^{232}Th(n,f) REACTIONS NEAR THE THRESHOLD. Nigro, S. Lo; Milone, C. (Univ., Catania, Italy. INFN, Catania, Italy). Nucl. Phys., A118: 461-6(1968).

The angular distributions of fragments from neutron-induced fission of thorium in the range $1.3 < E_n < 1.8$ MeV were measured by means of nuclear emulsions. From the analysis of the angular distributions, information was obtained on the strengths of various K-bands that contribute to the ^{232}Th(n,f) reaction. (auth)

50647 BETA-GAMMA DIRECTIONAL CORRELATION IN THE DECAY OF ^{148}Pm. Amadori, R. A.; Gupta, N. K.; Sastry, K. S. R. (Univ. of Massachusetts, Amherst). Nucl. Phys., A118: 33-40(1968).

The directional correlation involving the 1930 keV β-group in the decay of the 5.4 d ^{148}Pm and the 551 keV cascade γ-ray in ^{148}Sm was measured at nine β-ray energies in the range 1050–1700 keV. The correlation coefficient A_2 was found to be small and positive ($A_2 \approx +0.02$) in fair agreement with the expectations in the ξ-approximation and the work of Baba et al. The present results do not support the rather large negative values reported by Nainan and Moore. An attempt is made to interpret the data in terms of the β-decay matrix elements. An essentially isotropic correlation was measured for the $1^-(\beta)1^-(\gamma)0^+$ cascade. (auth)

50648 α-, β-, AND γ-SPECTROSCOPY. STUDIES OF SOME NUCLEAR PROPERTIES AND DECAY MODES OF RADIOACTIVE NUCLEI. Toernkvist, Soeren (Univ., Uppsala). Acta Univ. Upsaliensis, Abst. Uppsala Diss. Sci., 124: 1-15(Aug. 1968).

Fourteen published papers dealing with a decoupling experiment on the $\alpha-\gamma$ correlation in ^{243}Am, the $\beta-\gamma$ correlation in ^{198}Au, the electron capture decay of ^{133}Ba to the 437-keV level in ^{133}Cs, $L_2e-\gamma$ correlation in ^{199}Hg, directional correlation measurements with L_1 and L_2 conversion electrons of the 31-keV transition in ^{195}Pt, the penetration matrix element of the 279-keV transitions in ^{121}Te, nuclear structure effects in the particle parameters for the 84.2-keV transition in ^{231}Pa, nuclear spectroscopy of ^{133m}Ba, levels and transitions in ^{133}Cs, internal conversion studies of the 113-keV transition in ^{117}Hf, internal conversion studies of the 114-keV transition in ^{175}Lu, L and M electron directional correlations in ^{123}Te, and a versatile $e^- - \gamma$ correlation spectrometer are summarized. (SWEDEN)

50649 MEASUREMENT OF (n,2n) CROSS SECTIONS OF HEAVY NUCLEI. Dilg, W. (Technische Hochschule, Munich); Vonach, H.; Winkler, G.; Hille, P. Nucl. Phys., A118: 9-16 (1968). (In German).

Cross sections for (n,2n) processes induced by 14.7-MeV neutrons were measured by activation for nuclei ranging from Ce to Pb. The (n,2n) cross sections are 10 to 20% smaller than the total nonelastic cross sections of these nuclei. The data give little evidence for a dependence of the (n,2n) cross section on the asymmetry parameter (N − Z)/A and no evidence for shell effects. (auth)

50650 DECAY OF ^{152}Tb. Kaffrell, Norbert; Herrmann, Guenter (Univ., Mainz). Nucl. Phys., A118: 78-96(1968). (In German).

The beta and gamma radiations of ^{152}Tb were investigated employing scintillation and semiconductor spectrometers and coincidence techniques. Sources were produced by the ^{152}Dy(n,p) and ^{165}Ho(n,α) reactions. A half-life of 7.6 min was measured without evidence for an isomeric state in the half-life range of 2 sec to 8 d. The energies (in keV) and relative intensities (in parentheses) of the gamma rays were 81 (≈9), 185 (complex, 17 + 3.3), 260 (100), 622 (1.2), 697 (3.0), 807 (57), 882 (15), 888 (50), 1067 (0.8), 1194 (0.13) and 1275 (0.11). Beta-decay branches of 2.4 MeV (≈0.4%, log ft = 8.3), 1.5% (≈5%, 6.4), 1.25 (94%, 4.8) and 1.1 (0.2%, 7.2) were found, the 2.4 MeV branch leads to the ground state of ^{152}Dy. A spin and parity of 1^- was deduced for the ground state of ^{152}Tb. Levels of ^{152}Dy at 81, 266, 888, 963, 1148 and 1275 keV were populated in the decay of ^{152}Tb. The first four levels belong to the ground state and to the gamma-vibrational band. The level at 1148 keV was interpreted as a K, $I^\pi = 2,2^-$ state with a high contribution of the two-proton quasi-particle state [411↑-523↑], the level at 1275 keV as a collective $0,1^-$ state. (auth)

50651 ANGULAR DISTRIBUTIONS AND CROSS SECTIONS OF FRAGMENTS FROM NEUTRON-INDUCED FISSION OF ^{232}Th. Behkami, A. N. (Univ. of Rochester, N. Y. Argonne National Lab., Ill.); Huizenga, J. R.; Roberts, J. H. Nucl. Phys., A118: 65-77(1968).

Fission fragment angular distributions and cross sections were measured for the fission of ^{232}Th induced by mono-energetic neutrons of energies 1.20 ± 0.02, 1.40 ± 0.02 and 1.60 ± 0.02 MeV. The fission fragments were detected with approximately 2π geometry with a polycarbonate resin detector. The fission cross section and angular distribution both changed markedly with neutron energy. Information on the single-particle levels in the transition nucleus ^{232}Th was derived by fitting the experimental data with a Hauser–Feshbach type calculation which includes, in addition to the fission channels, the open neutron and gamma-ray decay channels taking into account level-width fluctuations. (auth)

50652 LEVEL STRUCTURE IN ^{167}Er. Funke, L.; Andrejtscheff, W.; Graber, H.; (and others) (Zentralinstitut fuer Kernforschung, Ger.). Nucl. Phys., A118: 97-113(1968). (In German).

The level scheme of ^{167}Er was investigated from the decay of ^{167}Ho (3 h) and ^{167}Tm (9.6 d). The gamma singles spectrum and gamma–gamma coincidence spectra were measured by means of Ge(Li) detectors and scintillation detectors. Furthermore, lifetime measurements were performed, and the maximum beta energy in the decay of ^{167}Ho was determined. About 15 new gamma-ray transitions were introduced in the level scheme of ^{167}Er. The intensity ratios of gamma-ray transitions from the $\frac{5}{2}^-$[523] rotational band were compared with the theoretical values. The half-life of the $\frac{5}{2}^-$[512] state at 346.5 keV is 1.0 ± 0.1 ns. A careful measurement of the gamma-ray spectrum from the ^{167}Tm decay showed weak lines at 323.7, 266.5 and 250.2 keV. (auth)

50653 MEASUREMENT OF α_K FOR THE 91.5-keV E2 TRANSITION IN ^{164}Er. Boneau, D.; Hatch, E. N. (Iowa State Univ., Ames). Nucl. Phys., A118: 238-40(1968).

The K-shell internal conversion coefficient, α_K, for the 91.5-keV $2^+ \rightarrow 0^+$ transition in the decay of ^{164}Ho to ^{164}Er was measured by the K x-ray/γ ratio method with scintillation crystals. Photons seen by the NaI detector were required to be in coincidence with continuous beta rays in order to eliminate effects of the competing electron capture decay of ^{164}Ho to ^{164}Dy. The experimental conversion coefficient $\alpha_K = 1.31 \pm 0.11$ agrees with the presently available theoretical values for an E2 transition. (auth)

50654 A STUDY OF THE LEVELS IN ^{56}Fe FROM INELASTIC SCATTERING OF DEUTERONS. Majumder, A. R.; Sen Gupta, H. M. (Univ. of Dacca, East Pakistan). Nucl. Phys., A118: 151-60(1968).

Energy levels in ^{56}Fe were obtained up to an excitation of 4.5 MeV from the inelastic scattering of 12 MeV deuterons by using a multi-gap magnetic spectrograph with nuclear emulsion as the detector. Angular distributions for these levels were measured, and the results were analyzed in terms of the distorted-wave method using the collective model of interaction by deforming both real and imaginary parts of the optical potential. Good agreement was found for the first 2^+ and the octupole vibrational states, and the corresponding deformation parameters were extracted. (auth)

50655 THE DECAY OF ^{131}La. Spalek, A.; Rezanka, I.; Frana, J.; Jursik, J.; Vobecky, M. (Nuclear Research Inst., Rez, Czech.). Nucl. Phys., A118: 161-73(1968).

The decay of ^{131}La ($T_{\frac{1}{2}}$ = 61 min) was investigated by means of Ge(Li) and Si(Li) spectrometers and Ge(Li)–NaI(Tl) coincidences. The decay scheme for ^{131}La includes four new levels. Of the two possibilities $\frac{1}{2}$ or $\frac{3}{2}$ for the ^{131}La ground state spin, the former value is preferred. (auth)

50656 GAMMA-RAY SPECTROSCOPY ON THE N = 82 NUCLEAR ISOTONES: ^{139}La, ^{140}Ce, ^{141}Pr, AND ^{142}Nd. Baer, Helmut Willy. Ann Arbor, Mich., Univ. of Michigan, 1967. 141p.

Thesis.

Gamma radiation from the N = 82 nuclei ^{139}La, ^{140}Ce, ^{141}Pr, and ^{142}Nd was investigated using the techniques of gamma-ray spectroscopy. Gamma-ray energies and intensities were measured with a 2-m curved-crystal spectrometer and Ge(Li) detectors. Gamma-ray decay sequences were determined by $\gamma-\gamma$ coincidence measurements. The energy values 165.854 ± 0.012, 145.4498 ± 0.0049, and 1575.42 ± 0.39 keV were determined for the excitation energies of the first excited states in ^{139}La, ^{141}Pr, and ^{142}Nd, respectively. A total of 26 gamma-ray energies and intensities were measured in the decay of ^{140}La to levels in ^{140}Ce. A decay scheme is presented which includes 15 excited levels and 28 γ-transitions. Twelve excited levels were found to be populated by β^--decay; log-ft values were determined using partial β transition probabilities and end-point energies. The multipole character of most of the γ-transitions could be determined when the present data were combined with recently published conversion electron data. The spins and parities of nearly all levels in ^{140}Ce populated via the decay of ^{140}La were determined. Of particular interest are the discovery of a 5^- level at 2350.2 keV and an isomeric, 6^+ level at 2108.2 keV; they are the first states with these J^π values identified in N = 82 nuclei. A compilation and discussion of the properties of N = 82 nuclei are presented; evidence for special structure at N = 82 is reviewed. The excitation spectra are discussed in the framework of the quasi-particle description of pairing correlations in spherical nuclei. Future experiments using the techniques of radioactive decay and nuclear reactions are proposed. (Disser. Abstr.)

Nuclear Theory

Refer also to abstracts 49104, 50224, 50356, 50530, 50544, 50546, 50553–50556, 50560, 50581, 50605, 50607, 50614, 50624, 50626, and 50642.

50657 (ANL–7467) INTERFERING RESONANCES. Moldauer, P. A. (Argonne National Lab., Ill.). July 1968. Contract W-31-109-eng-38. 16p. Dep. CFSTI.

Unresolved resonances are discussed for the case in which resonances of the same angular momentum in a single isotope have widths whose magnitudes approach and eventually exceed the spacings of such resonances. The cross-section behavior is dominated by resonance interference. It is shown that even the values and relations among resonance parameters are dominated by interference effects. (J.W.R.)

50658 (UCRL-18214) AVERAGE NUCLEAR PROPERTIES. Myers, William Don (California Univ., Berkeley. Lawrence Radiation Lab.). May 1, 1968. Contract W-7405-eng-48. 150p. Dep. CFSTI.

Thesis.

A generalized treatment of average nuclear properties is presented. The theory is developed on two levels: First a refinement of the Liquid Drop Model, called the Droplet Model, is described. The degrees of freedom in this model, in addition to the usual shape variables, are variables specifying deviations from uniformity of the neutron and proton densities. The form of the Hamiltonian defining the Droplet Model, of which only the potential energy part is considered in this paper, is derived by expanding the volume, surface, and Coulomb energies in Taylor series around the standard Liquid Drop Model values. Such an expansion, designed to retain all terms in the total energy up to order $A^{\frac{1}{3}}$, $I^2A^{\frac{1}{3}}$, and I^4A, where $I = (N-Z)/A$, turns out to contain eleven parameters, two of which may be eliminated. Four of the resulting nine parameters are the standard adjustable parameters of the Liquid Drop Model and five are new coefficients specifying various properties of nuclear systems. (Nuclear compressibility and the curvature correction to the surface tension are two examples.) Minimizing the Droplet Model potential energy with respect to density variations leads to equations, in closed form, specifying the separate neutron and proton radii and the density nonuniformities. The minimized energy expression leads to a refined Droplet Model Mass Formula with nine parameters. The second level at which average nuclear properties are treated is based on assuming a concrete model of a two-component saturating system, consisting of neutrons and protons interacting by velocity-dependent Yukawa forces (and Coulomb forces). When this model is treated in the Thomas–Fermi approximation a pair of coupled integral equations results, which can be used as the basis of a self-contained model of all average static nuclear properties. The solutions of these equations are discussed in the idealized situations of nuclear matter and semi-infinite nuclear matter, and for finite nuclei both with and without Coulomb energy. One result of these studies is the determination of the values of the five new Droplet Model parameters. Other results have to do with the nuclear density distributions, and the binding energies. The applications of the Droplet Model and Thomas–Fermi Model discussed include predictions concerning neutron and proton radii (in particular the presence of a neutron skin), the isotope effect in proton radii, the compression of the nucleus by the surface tension and the dilatation by the Coulomb energy, and the central depression in the densities caused by the Coulomb repulsion. Calculations are made for the surface curvature correction, for the surface symmetry energy, and for a modification to the volume symmetry energy at a large neutron excess. A revised estimate is made for the value of the symmetry energy of nuclear matter. Also treated is the question of whether or not neutron matter is bound, and some discussion is given of the spatial distribution, the energy dependence, and the composition dependence to be expected for nuclear optical model potentials on the basis of the statistical methods used. (auth)

50659 INTERMEDIATE STRUCTURE IN FISSION. Feshbach, Herman; Kerman, Arthur K. Comments Nucl. Particle Phys., 11: 125-9(July-Aug. 1968).

An explanation of the intermediate structure in subthreshold fission is proposed in which the neutron is captured into a normal compound level with the system proceeding to penetrate the first fission barrier and to oscillate in the fission mode contained in the second minimum. It also mixes with the compound levels there. Finally, it penetrates the second barrier. When a normal compound level has an energy close to one of the levels in the second minimum, the probability of fission is increased; far away it is decreased, accounting for the intermediate structure. (D.C.W.)

50660 THE SPIN STRUCTURE OF NUCLEAR REACTIONS OF TYPE $1 + 1 \rightarrow 0 + 0$. Koehler, W. E.; Fick, D. (Univ., Erlangen, Ger.). Z. Phys., 215: 408-18(1968). (In German).

The nondynamical M-matrix formalism is applied to reactions of spin type $1 + 1 \rightarrow 0 + 0$. For this purpose rectangular spin matrices are introduced. It is shown that there are only 7 linearly independent analyzing powers. Thus, to get complete information for reactions with all particles having parity +1, experiments with both beam and target being polarized have to be carried out. At present, this is possible for the ^{6}Li(d,α)α reaction, where a polarized ^{6}Li beam and a polarized deuteron beam or target are available. (auth)

50661 MOMENT OF INERTIA AT THE SADDLE POINT OF LOW-ENERGY FISSION OF EVEN-EVEN NUCLEI. Roesch, Notker (Technische Hochschule, Munich). Z. Phys., 215: 368-76(1968).

The molecular model of low-energy fission, which describes the nucleus by two interacting fragments, was used to calculate the moment of inertia for ^{236}U in the cranking approximation including BCS theory. It is shown that the moment of inertia at the saddle point depends almost linearly on the fragment distance, is influenced only very weakly by the pairing constant and by the fragment deformations, and is approximately that of a rigid body. Also, as a function of the distribution of mass between the two fragments (A_1,A_2), it has a minimum near the magic configuration $A_1 = 132$, $Z_1 = 50$ and depends in this mass region strongly on the term structure near the Fermi energy. (auth)

50662 THE ELASTIC SCATTERING OF 9.6-MeV PROTONS AND THE REFORMULATED OPTICAL MODEL. Berovic, N. (Univ. of Birmingham, Eng.); Rolph, P. M.; Scarrott, S. M. Phys. Lett., 27B: 477-8(Sept. 16, 1968).

An analysis of experimental results on proton elastic scattering at 9.6 MeV was carried out to obtain real potential volume integrals and mean square radii for the matter, proton, and neutron distributions. It is found that in ^{40}Ca protons extend further out from the centre than neutrons, contrary to the situation in other nuclei analyzed. (auth)

50663 THEORY OF NUCLEAR ENERGY LEVELS. Irvine, J. M. (Cornell Univ., Ithaca, N. Y.). Rep. Progr. Phys., 31: 1-59(1968).

The basic features of the collective and shell models of nuclear structure are reviewed. A detailed comparison between the experimentally observed energy levels and those obtained by theoretical calculations is presented for a large number of nuclei. The effect of nuclear correlations within the framework of the shell model is investigated. Two correlation effects are studied in detail: the predictions of the particle–hole random phase approximation of the commonly observed coherent vibrational states, and the pairing correlations of the superfluid nuclear model. The extension of the shell model to include representations of basis states corresponding to configurations which possess equilibrium deformations is discussed. A brief account of some recent studies of the self-consistent structure of nuclei is given in an attempt to lay a sounder foundation for the nuclear shell model. (auth)

50664 NUCLEAR STRUCTURE. Willmott, J. C. (Univ. of Manchester, Eng.). Phys. Bull., (London), 19: 289-96(Sept. 1968).

A review is given under the following headings: historical; nuclear structure comes of age; further developments (independent-particle shell model); collective motion and the unified model; nuclear reactions; direct interactions; and future prospects. (UK)

50665 STATIC NUCLEAR DEFORMATION EFFECTS IN INTERNAL CONVERSION. Matese, J. J. (Louisiana State Univ., Baton Rouge). Phys. Rev., 173: 1165-9(Sept. 20, 1968).

The effect of the static nuclear quadrupole moment on atomic electrons is investigated. In particular, we consider how this effect influences the internal-conversion process. Other higher-order corrections which involve electron and nuclear intermediate states are neglected, as is the induced quadrupole moment of the electron cloud. Theoretical expressions for EL and ML internal-conversion coefficients, including nuclear deformation contributions, are presented. Numerical calculations of these corrections were performed for the L subshells of several transitions in the rare-earth region using the "no-penetration" model. Screening is neglected but finite nuclear size is included. The results are presented as ratios of the correction contribution to the uncorrected, unscreened conversion coefficient in order to reduce the error associated with the neglect of screening. The percent corrections obtained in this manner are found to be two orders of magnitude smaller than the observed discrepancies between experiment and existing theory. (auth)

50666 EXTENDED R-MATRIX THEORY OF NUCLEAR REACTIONS. Garside, L.; Tobocman, W. (Case Western Reserve Univ., Cleveland). Phys. Rev., 173: 1047-54(Sept. 20, 1968).

The R-matrix theory of nuclear reactions is modified so that (a) the collision matrix can be constructed from the Hamiltonian eigenfunctions and eigenvalues provided by any nuclear-structure calculation for the compound nucleus, (b) the results of an optical-model or coupled-channel-model calculation can be incorporated into the expression for the collision matrix to represent the nonresonant background scattering, and (c) the direct-reaction contribution to the reaction can be separated from the resonant part. The resonance contribution to the R matrix can be evaluated from the compound-nucleus eigenstates on the basis of a truncation approximation or of a projection-operator approximation. (auth)

50667 ISOTOPIC-SPIN MIXING IN DIRECT AND COMPOUND-NUCLEAR REACTIONS. Noble, J. V. (Univ. of Pennsylvania, Philadelphia). Phys. Rev., 173: 1034-46(Sept. 20, 1968).

The semidirect mechanism of isospin violation in deuteron-induced nuclear reactions, which was presented in an earlier article, is recapitulated. A number of reactions involving the same basic mechanism are discussed and the available data on them are briefly reviewed. This mechanism also leads to much stronger isospin mixing in certain levels in light nuclei than is predicted by the usual perturbative treatment of Coulomb interactions. Such mixing is discussed in terms of a simple two-level model. A suggestion by Levinson has led to a reexamination of the Wilkinson hypothesis that isospin-violating reactions proceed via formation of isotopically impure compound-nuclear levels at "intermediate" excitation energies. It is shown that the most important factor in determining the contribution of these levels is not their degree of isospin mixing, but rather the experimental energy resolution. If the resolution I is poor compared to the average spacing $\langle D_J \rangle$ of levels of given J^P, then in general the contribution of these levels is reduced by the ratio $\langle D_J \rangle / I$. When compound levels are so correlated as to give rise to intermediate structure, or a giant resonance, or an isobaric analog state, their contribution to the isospin-nonconserving amplitude need not be small. This implies that isospin-violating reactions are ideally suited to the study of intermediate structure. Because the actual level density in light nuclei at intermediate excitation is not well known, it is not clear whether Levinson's suggestion is relevant to the studies so far conducted on (a) $^{12}C(d,\alpha)^{10}*B$ (1.74, T = 1), and (b) $^{16}O(d,\alpha)^{14}*N$ (2.31, T = 1). It is surely relevant to heavier compound nuclei, however, and estimates based on a statistical level-density formula suggest that Levinson's idea is even relevant for the ^{14}N and ^{18}F compound nuclei entering reactions (a) and (b) above. Finally, the data of Meyer-Schützmeister et al. are analyzed for evidence of compound-direct interference. It is conjectured on the basis of a crude but suggestive calculation that the broad 3^- (with some possible 1^- admixture) resonance seen by them in ^{14}N at $E_x \sim 18$ MeV is actually an intermediate-structure resonance whose "doorway state" is a "single-particle cluster resonance" in either the entrance or exit channels, or in both. A brief theoretical discussion of compound-direct interference is included for completeness. (auth)

50668 HIGH-ENERGY NONLOCAL NUCLEON–NUCLEUS OPTICAL POTENTIAL FOR A CENTRAL TWO-BODY FORCE WITH SECOND-ORDER CORRECTIONS TO THE IMPULSE APPROXIMATION. Reading, J. F. (Univ. of Washington, Seattle); MacKellar, Alan D. Phys. Rev., 173: 1026-33(Sept. 20, 1968).

A calculation of the high-energy nucleon-nucleus optical potential is carried out for a central two-body force in the energy region 90 to 310 MeV. It is first shown that arbitrarily assuming a reduced mass of 0.44m for the two-body collision in the nucleus improves the fit to experiment. A novel method is then presented for correcting the impulse approximation for terms of second order in the two-body force. Application of this method indicates that the impulse approximation is reliable at 310 MeV. Considerable corrections are found below this energy which substantially decrease the discrepancy between theory and experiment. Off-energy-shell nonlocal effects are of third order in the three-body force and can not be included with complete consistency. However, there are indications that they might be small. Pair-correlation effects are ignored throughout this work. (auth)

50669 SECOND BORN CORRECTIONS TO WIDE-ANGLE HIGH-ENERGY ELECTRON PAIR PRODUCTION AND BREMSSTRAHLUNG. Brodsky, Stanley J.)stanford Univ., Calif.); Gillespie, John R. Phys. Rev., 173: 1011-21(Sept. 20, 1968).

Cross sections, correct to second order, are derived for the photoproduction of wide-angle electron pairs in a spherical, static nuclear charge distribution. For typical double-coincidence experiments, it is found to be sufficient to treat only the convection current of the electron. The results obtained are essential to the interpretation of asymmetric electron pair production and may also be applied to wide-angle electron bremsstrahlung. For noncoincidence experiments in which one lepton is detected with most of the available energy, the higher Born corrections are shown to be identical with those of electron scattering. Numerical results are presented. The large asymmetries which have been reported for coincident pairs produced on a lead target are satisfactorily explained by the second Born contribution. The predicted asymmetry for pairs produced in carbon with invariant pair mass near the ρ^0 mass is small compared with the Compton contribution. (auth)

50670 NUCLEAR-MATTER CRITERION FOR SEMIREALISTIC HARTREE–FOCK INTERACTIONS. Pearson, J. M.; Saunier, Gerard (Univ. of Montreal). Phys. Rev., 173: 991-4(Sept. 20, 1968).

An extension is presented of an earlier paper in which it was proposed that the effective interaction for nuclear Hartree-Fock calculations should conform in the long-range part to the real nucleon–nucleon interaction, while the short-range part should be purely phenomenological, being adjusted so that the entire interaction saturates nuclear matter correctly in the Hartree-Fock approximation, with small second-order terms. The extent to which the finite-nucleus results depend on the precise form of the phenomenological part of such an effective interaction is investigated. Considering the specific cases of the doubly-closed-shell nuclei ^{16}O and ^{40}Ca, calculated in the well-tested oscillator approximation, it is found that their binding energies are quite insensitive to the phenomenological part of the interaction and are in good agreement with experiment, provided the range of this part of the interaction does not exceed a certain value, and the same nuclear-matter binding energy and density are always fitted. However, these conditions are not sufficient to obtain a unique nuclear radius. The radius is also sensitive to the nuclear-matter compressibility. Experimental information on this latter quantity is lacking, but an estimate based on a very crude examination of breathing modes leads to reasonable values of nuclear radii. (auth)

50671 NEUTRON SPECTROSCOPIC FACTORS FROM ISOBARIC ANALOG STATES. Thompson, W. J.; Adams, J. L.; Robson, D. (Florida State Univ., Tallahassee). Phys. Rev., 173: 975-90(Sept. 20, 1968).

The spectroscopic factors S_n of bound neutron states are usually found from (d,p) stripping reactions. An alternative method of finding S_n for medium-to-heavy nuclei is to analyze isobaric analog resonances observed in (p,p) scattering from these nuclei. The present analysis uses a modified R-matrix theory in which boundary matching is done within the optical-model potential region rather than directly onto the Coulomb potential region. A resonance mixing phase and an optical penetrability are introduced. Both single- and multilevel resonances are treated. The effects of compound elastic scattering and the energy dependence of the level shift are investigated. Formulas for the spreading width are obtained. The variation of S_n with the value of the matching radius and the best choice of this radius are discussed. As examples of the method, analyses of the s-wave resonance in $^{92}Zr(p,p)^{92}Zr$ near 6.0-MeV bombarding energy and of s- and d-wave resonances in $^{90}Zr(p,p)^{90}Zr$ near 5.8 and 6.8 MeV are presented. The values of S_n obtained are compared with those from (d,p) experiments, and the reliability of the two methods is discussed. (auth)

50672 OVERLAPPING COMPOUND-NUCLEUS RESONANCES. Ullah, Nazakat (Tata Inst. of Fundamental Research, Bombay). Phys. Rev., 173: 971-5(Sept. 20, 1968).

A simple model to study two overlapping compound-nucleus resonances is constructed. Expressions have been derived for the joint probability distribution of the spacing and the widths of the collision matrix for the elastic and inelastic scattering. In the inelastic case, only a two-channel problem is considered. It is shown that the unitarity gives rise to the statistical correlation between the width and the spacing of the collision matrix. The model is also used to check which of the relations between the averages of the parameters of the statistical collision matrix, obtained using the ensemble of random complex orthogonal matrices, are consistent with the constraint of unitarity. (auth)

50673 $A^{-1/3}$ DEPENDENCE OF GIANT DIPOLE ENERGIES. Bach, Richard (Catholic Univ. of America, Washington, D. C.); Werntz, Carl. Phys. Rev., 173: 958-63(Sept. 20, 1968).

Goldhaber and Teller suggested a model for the giant E1 transition resonance in which the sphere of neutrons oscillates against the sphere of protons. Using simple arguments it was shown that such a model predicts an $A^{-1/3}$ dependence of the dipole energy on atomic weight. However, Steinwedel and Jensen introduced a hydrodynamic model of the nucleus with a rigid nuclear surface that predicted an $A^{-1/3}$ behavior. A semiqualitative estimate of the energy was obtained by using as the restoring force the symmetry energy term in the semiempirical mass formula. A hydrodynamic model is presented which includes a realistic nuclear surface and shows that an $A^{-1/3}$ behavior is again predicted. A plot of the data for nuclei from ^4He to ^{238}U shows that the log $\bar{\omega}$ values, where $\bar{\omega}$ is the average energy of absorption for a given nucleus, fall on a straight line with slope of $-1/6$. (auth)

50674 NEW THEORETICAL APPROACH TO NUCLEAR HEAVY-ION SCATTERING. Brueckner, Keith A.; Buchler, J. Robert.; Kelly, Michael M. (Univ. of California, San Diego, La Jolla). Phys. Rev., 173: 944-9(Sept. 20, 1968).

A new theoretical approach to the study of the nuclear interaction between heavy ions is presented. The potential governing the collision between complex nuclei is derived from a statistical theory of finite nuclei based on nuclear-matter calculations and is presented as an application to the ^{16}O-^{16}O elastic scattering process. A phase-shift analysis of the experimental data on ^{16}O-^{16}O scattering is performed which shows, first, that an excellent fit

can be obtained with a real potential up to 14 MeV, and second, that there exists a short-range repulsion. The best-fit potential is in close agreement with the calculated potential in the attractive region, but has a weaker and shorter-range repulsion. (auth)

50675 LOW-ENERGY PHYSICS FROM A HIGH-ENERGY STANDPOINT. Schiff, Leonard I. (Stanford Univ., Calif.). Science, 161: 969-73(Sept. 6, 1968).

The application of high-energy techniques to the study of the low-energy properties of atomic nuclei is discussed. Particular attention is paid to recent work on the elastic scattering of electrons by Ca isotopes and to the comparison of the elastic scattering of electrons and protons by He. (J.W.R.)

50676 INELASTIC SCATTERING OF HIGH-SPEED ELECTRONS BY NUCLEI WITH NUCLEON KNOCKOUT. Tartakovskii, V. K.; Pasichnyi, A. A. (Kiev State Univ.). Ukr. Fiz. Zh., 13: 1361-8(Aug. 1968). (In Russian).

The process of nucleon knockout by high-energy electron is studied using the independent particle model in the LS coupling scheme. A differential cross section of electron inelastic scattering is calculated for which the electron-nucleon magnetic interaction and the Darwin term are taken into account. Angular and energy distributions are obtained for the reaction products. The dependence of cross section on initial and finite nuclear states is discussed. (auth)

50677 RADIO FREQUENCY ION SOURCE. Morsy, M. W.; Hanna, N. N. IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-15: No. 5, 18-20(Oct, 1968).

A radiofrequency positive ion source employing a nonmagnetic analyzer is proposed with eventual purpose to overcome the difficulties involved in confining, extracting and filtering ion beams. (auth)

50678 TESTS OF TIME-REVERSAL INVARIANCE OF STRONG INTERACTIONS UTILIZING THE MOESSBAUER EFFECT. Hannon, J. P.; Trammell, G. T. (Rice Univ., Houston, Tex.). Phys. Rev. Lett., 21: 726-32(Sept. 9, 1968).

The currents induced in the inner electronic shells by a nuclear Moessbauer γ transition gives an $E(L+1)-M(L)$ phase difference on the order of 10^{-2} to 10^{-3} RAD which must be taken into account in the interpretation of experiments designed to detect such phase differences arising from possible failure of T invariance in nuclear interactions. (auth)

50679 NUCLEAR MASS DISTRIBUTION RADII FROM ELASTIC NEUTRON SCATTERING. Holmqvist, B.; Wiedling, T. (AB Atomenergi, Studsvik, Sweden). Phys. Lett., 27B: 411-13 (Sept. 2, 1968).

From optical model analyses of fast neutron elastic scattering, evidence is presented for the existence of a nuclear matter distribution extending beyond the nuclear charge distribution. (auth)

50680 HARTREE-BOGOLYUBOV THEORY WITH PROJECTION METHOD. Onishi, Naoki (Tokyo Inst. of Tech.). Progr. Theor. Phys. (Kyoto), 40: 84-98(July 1968).

The theory of Rouhaninejad and Yoccoz concerned with the self-consistent calculation with projection method is extended to take into account the pairing correlation. The variational method is used in which the trial function involving a definite angular momentum is generated by using the BCS wave function. The first-order correction to the self-consistent field due to the rotation contains two parts, with $K = 0$ and with $K = 1$. The correction to the density matrix with $K = 1$ and that to the pairing tensor with $K = 1$ is proportional to $\sqrt{I(I+1)}$. They do not, however, contribute to the rotational energy in the lowest order of the inverse of the expectation value of the square of the angular momentum. (auth)

50681 THEORY OF PROJECTION OF SPURIOUS CENTER OF MASS AND ROTATIONAL STATES FROM MANY-BODY NUCLEAR WAVE FUNCTIONS. Scheid, Werner; Greiner, Walter (Univ. of Virginia, Charlottesville. Univ., Frankfurt am Main). Ann. Phys. (N. Y.), 48: 493-525(July 1968).

A general procedure for projecting spurious center of mass and spurious rotational states from many-body nuclear wave functions is given. The procedure is based on the method of redundant variables. The spurious degrees of freedom are projected by adding well-defined potentials in the redundant variables. It is shown that the center-of-mass motion can be separated for arbitrary single-particle potentials. As a simple example, the method is quantitatively carried through for the center-of-mass projection from a deformed oscillator potential. In addition, this procedure is applied to eliminate spurious rotational states which are contained in the intrinsic motion of a microscopic description for deformed nuclei. This description is based on an earlier discussion of nuclear rotational states by Villars. For many-body nuclear wave functions obtained in a Nilsson-type model, estimates of the rotational spuriosity are given. (auth)

50682 FOUR-BODY CORRELATIONS IN LIGHT NUCLEI. THE INTERACTION BETWEEN A FOUR-BODY MODE AND A SINGLE-HOLE MODE. Eichler, Joerg; Marumori, Toshio; Takada, Kenjiroe (Kyushu Univ., Fukuoka). Progr. Theor. Phys. (Kyoto), 40: 60-83(July 1968).

Using the many-body description of α-like four-body modes originated by Marumori and Suzuki, a new theory for treating the famous low-lying $\frac{1}{2}^-$ state in ^{19}F and the $\frac{1}{2}^+$ state in ^{43}Sc is proposed. These states are considered to consist of an α-like four-body mode and a single-hole mode. Starting from the shell-model Hamiltonian with a general two-body interaction, the effective interaction between the α-like four-body mode and the single-hole mode is derived. It is shown that, due to ground-state correlations (responsible for the α-like four-body mode), the effective interaction is weakened, compared with the interaction estimated by a standard shell-model calculation (without ground-state correlations). This fact strongly supports the basic conjecture of the "weak-coupling model of particles and holes in the sd shell nuclei" proposed by Arima, Horiuchi and Sebe, and also supports a phenomenological model proposed by the Hokkaidō-group in which the importance of the α-particle mode is explicitly displayed. (auth)

50683 RECTANGLE DIAGRAMS IN THE (p,p'), (d,d'), (t,p)–(^{6}He,p) REACTIONS ON SOME NUCLEI OF p-SHELL AND A SIMPLE METHOD FOR CALCULATING THEIR ANGULAR DISTRIBUTIONS. Neudatchin, V. G.; Zelenskaya, N. S.; Magzumov, E. Zh.; Romanovskii, E. A. (Moscow State Univ.). Phys. Lett., 27B: 490-3(Sept. 16, 1968).

The mechanism described by the rectangle diagram is used for calculating the cross sections of the (p,p'), (d,d'), (t,p)–(^{6}He,p) reactions. A simplified method which is a generalization of the method of calculation of reduced widths of nucleon clusters is proposed for calculating the amplitudes of rectangle diagrams with plane waves. (auth)

50684 TIME DEPENDENCE OF RESONANCE SCATTERING. Acker, H. L. (Univ. of Virginia, Charlottesville). Z. Phys., 216: 84-93(1968).

The process of resonance scattering is studied in a time-dependent approach. A formulation is given in which one can see the time dependence of the prompt potential scattering and the delayed resonance scattering. It is shown that the usual expression for the resonance scattering is obtained in an experiment in which the detectors are sensitive during a long time. Switching off the detectors after some time comparable to the lifetime of the resonance yields considerable modifications of the cross section: a broadening of the resonance and oscillations are observed in this case. (auth)

50685 RECOUPLING COEFFICIENTS OF THE SYMMETRIC GROUP FOR SHELL AND CLUSTER MODEL CONFIGURATIONS. Kramer, P. (Univ., Tuebingen, Ger.). Z. Phys., 216: 68-83 (1968).

Recoupling coefficients of the symmetric group are defined from the reduction of irreducible representations of this group to direct product representations of particular subgroups. These recoupling coefficients are analyzed and shown to be identical to the invariants of unitary groups arising from the reduction of Kronecker product representations. The recoupling coefficients have applications in configurations of several shells or clusters. (auth)

50686 OPTICAL POTENTIAL FOR THE DEUTERON. Mukherjee, Suprokash (Australian National Univ., Canberra). Nucl. Phys., A118: 423-35(1968).

The optical potential of the deuteron is expressed in terms of neutron and proton optical potentials using the operator formalism of Feshbach. A fairly good description of the real and imaginary parts of the deuteron optical potential is obtained only when a few correction terms are taken into account. (auth)

50687 NUCLEAR PHOTON SCATTERING (II). Silbar, R. R. (Los Alamos Scientific Lab., N. Mex.). Contract W-7405-eng-36. Nucl. Phys., A118: 389-408(1968). (LA-DC-9241).

The general formalism for nuclear photon scattering presented earlier is simplified and recast in a form more useful to experimentalists. All photon polarization and nuclear orientation effects are included. The cross sections are written as "Fourier series" of angular functions involving the photon directions. The coefficients in this series depend only on nuclear properties and contain the same reduced matrix elements of the nuclear current and magnetization density that enter the theory of photo- and electro-excitation. Special geometries and experimental situations are discussed, and numerical examples involving E1-E2 and E1-M1 interference are presented. (auth)

50688 THE INTERMEDIATE STRUCTURE IN NUCLEAR RESONANCE REACTIONS. Stancu, Floarea (Inst. of Atomic

Physics, Bucharest). Stud. Cercet. Fiz., 20: 473-501(1968). (In Rumanian).

Three types of structure may be distinguished in nuclear reaction experiments on the basis of resonances of the cross section determined as a function of the incident energy: gross structure, fine structure, and intermediate structure. The latter is observed in both light and heavy nuclei; its resonances are characterized by well-determined quantum numbers. The intermediate structures of reactions yielding the same compound nucleus exhibit special correlations between each other. The intermediate resonances are not random fluctuations but reflect clearly the dynamics of the process. This type of structure is explained by the "doorway" theory of B. Bloch and H. Feshbach. The main features of Feshbach's theory are outlined, limiting the discussion to elastic collisions. This theory has been applied only to reactions in which there is only a single nucleon in the open channels. The theory explains photonuclear reactions; elastic scattering by light nuclei by means of particle–hole excitation; and collision of neutrons with light nuclei; such as ^{15}N, ^{12}C, and ^{19}F. (TTT)

50689 CORRECTIONS TO HIGH-ENERGY ELECTRON-NUCLEUS SCATTERING. Onley, D. S. (Ohio Univ., Athens). Nucl. Phys., A118: 43C-48(1968).

The effect of excitation of intermediate nuclear states on both elastic and inelastic electron scattering is examined. The method employed is the DWBA carried to second order in the transition potential. For high incident energy ($E_e \gtrsim 200$ MeV) the second-order terms can be simplified by ignoring the nuclear excitation energy, and by using simple forms for the transition charge densities. The dispersion corrections are then independent of the details of the level structure of the target nucleus. Sample calculations are presented for scattering processes from ^{40}Ca, ^{58}Ni, and ^{208}Pb, to which intermediate dipole states may contribute. The effect of quadrupole states is also included for elastic scattering. The most important corrections ($\gtrsim 20\%$) occur in elastic scattering at high momentum transfer ($q \gtrsim 500$ MeV/c) and are more pronounced in light nuclei than heavy ones. (auth)

50690 METHOD OF UNITARY TRANSFORMATIONS IN THE THEORY OF NUCLEAR MATTER. Ristig, M.; Kistler, S. (Univ., Cologne). Z. Phys., 215: 419-30(1968).

The theory of nuclear matter is investigated by means of the method of unitary transformations in the special case of point transformations. The general formula for the energy per particle as a function of the density is given in Hartree-Fock approximation being neglected the induced three and more body forces for reasonable correlation functions. This function always shows saturation due to a term proportional to k_F^5 in the direct part of the approximation. The physical connection of this term with the scattering amplitudes of the potential is shown. The equivalence to order k_F^3 of the energy per particle function of the unitary method with Jastrow and separation methods in their simplest form is pointed out. The saturation properties are calculated for certain classes of correlations using the realistic potential of Gammel, Christian, and Thaler. (auth)

50691 COMPUTERS AND NUCLEAR PHYSICS. Birnbaum, Joel (IBM Watson Research Center, Yorktown Heights, N. Y.); Sachs, Martin W. Phys. Today, 21: No. 7, 43-51(July 1968).

The advantages of using computers as integral part of the experimental apparatus to simultaneously acquire, reduce, and analyze data, and to report the results, are given. Applications in nuclear physics are described, but the general concepts are applicable in most areas of research. (J.W.R.)

50692 ON SLATER VARIATIONAL CALCULATIONS FOR ^4He. Gibson, B. F.; Goldberg, A.; Weiss, M. S. (Univ. of California, Livermore). Nucl. Phys., A118: 225-37(1968).

A comparison of Hartree–Fock and Limited Hartree–Fock calculational methods was carried out for the specific case of ^4He with Volkov two-body potentials. For this potential, there proves to be no significant difference between results of the two methods; these results include total binding energies, single-particle separation energies and the charge form factor. Proper treatment of the center-of-mass motion is essential and has been included. We have found that second-order corrections to the binding energy are large, but arguments (derived from an approximant diagonalization of the total Hamiltonian) are given that the first-order results are in fact quite accurate. (auth)

50693 PAIRING CORRELATIONS IN NUCLEAR MATTER: A SELF-CONSISTENT CALCULATION. Kennedy, Roger C. (Australian National Univ., Canberra). Nucl. Phys., A118: 189-206 (1968).

Pairing correlations in nuclear matter are examined in a full self-consistent model defined by a slightly generalized Bogoliubov-Valatin transformation on the entire Hamiltonian. Exact solutions of this model, employing realistic s-wave nuclear–nuclear interactions, are compared with simpler models in which single-particle energies are given by the Hartree–Fock and effective mass approximations. It is concluded that there is some difference between the self-consistent and the Hartree-Fock calculations especially at low nuclear densities. Differences with the effective mass approximation are still greater. The important conclusion reached in the past remains unchanged; namely, at normal nuclear densities the energy gap in nuclear matter is smaller than that observed in heavy finite nuclei by a factor of about 10^{-3}. (auth)

50694 THE COULOMB AND CENTER-OF-MASS CORRECTIONS TO THE NUCLEAR HARTREE–FOCK CALCULATIONS. Gunye, M. R. (McMaster Univ., Hamilton, Ont.). Nucl. Phys., A118: 174-84(1968).

The effects of the Coulomb and center-of-mass corrections on the Hartree–Fock calculations are explicitly evaluated for several nuclei in the 2s-1d shell. It is seen that the center-of-mass correction is quite significant for the energies of the lower single-particle Hartree-Fock orbitals and the overall correction to the binding energy can be expressed in the form $(a/A)\exp(-bA)$, where A is the mass number and a, b are constants. The Coulomb correction is found to increase the gap between the last occupied and the first unoccupied proton orbits and the main correction to the binding energy is proportional to $Z(Z-1)/A^{\frac{1}{3}}$ where Z is the number of protons. The effect of the correction terms on the rms radii and the intrinsic quadrupole moment of the deformed nucli is found to be insignificant (<2%). The effect of these corrections on the mass and charge density distributions is also studied. The calculated rms radii for both mass and charge distributions in the 2s-1d shell nuclei indicate that the $A^{\frac{1}{3}}$ dependence is not valid. (auth)

50695 FOUR-BODY FORCES IN NUCLEAR MATTER. Brown, G. E.; Green, A. M.; Gerace, W. J.; Nyman, E. M. (Princeton Univ., N. J.). Nucl. Phys., A118: 1-8(1968).

It is shown that in nuclear matter the long-range four-body force due to the interaction between virtual points is negligibly small. This result is independent of the strength of the π-π interaction for any reasonable values. (auth)

50696 NONLOCAL MODEL T MATRICES IN A QUASI-THREE-BODY REACTION. Deutchman, Philip Allen. Portland, Oregon, Univ. of Oregon. 123p.

Thesis.

The (p,2p) cross section is calculated using local and nonlocal (p,p) effective interactions. The quasi-three-body assumption is used in which the effects of other channels are taken into account with a complex potential. The formalism used is the distorted-wave t-matrix approximation in the static limit. The distorted waves are approximated by fairly simple, but realistic optical wave functions. The parameters involved in these approximate optical waves are determined using a local t-matrix and a good fit to the more complicated DWTA theory is obtained. The effects of these parameters on the (p,2p) cross sections are indicated. Then three values for the nonlocal range parameter R are chosen, one of which is the local t-matrix and the parameters in all the t-matrices are adjusted so as to fit (p,p) scattering as closely as possible. The theoretical calculations fit the experimental (p,p) energy distribution at 90° in the center of mass system over a wide range of energies. Then the (p,2p) angular distributions are calculated using the nonlocal t-matrices and the local and nonlocal (p,2p) cross sections are compared to each other as well as to the experiment. It is seen that the off energy shell effects associated with each t-matrix are discernible from each other, and a fairly good fit to experiment is obtained with R = 0.6 fm. (Disser. Abstr.)

REACTOR TECHNOLOGY

Central Power Reactors

Refer also to abstracts 48957, 48958, 48980, 48981, 48984, 49032, 49739, 49788, 49796, 49815, 49822, 49852, 49857, and 49858.

50697 (AECL–3156) A COMPARISON OF CANADIAN AND US SITING POLICIES. Hake, G. (Atomic Energy of Canada Ltd., Chalk River (Ontario). Chalk River Nuclear Labs.). June 1968. 12p. Dep. CFSTI. CAN $0.50.

The siting conditions that apply to the Canadian Pickering and the U.S. Indian Point-2 and Oyster Creek stations are analyzed in a general way to show that in both countries, the approval of these stations has involved three similar conditions: a fifth order reduction in the total risk; credit for active components of the containment system equivalent to a first or second order reduction of risk; and similar population doses of about 10^6 thyroid Rems. It is suggested that a requirement based on a population dose limit is likely to be more easily accommodated than a requirement based on a population dose limit is likely to be more easily accommodated than a requirement based on a population distance limit. It is also suggested that in the practical siting situations likely to arise, the individual dose at the exclusion boundary will govern and the population center distance criteria as presently defined in the U.S. regulations are then unnecessarily restrictive. (auth)

50698 (ANL–7433) CONTROL SYSTEM FOR TRACE HEATING ON EBR-II SECONDARY SODIUM PIPING. Moriarty, K. J.; Just, F. H.; Rovig, M. D. (Argonne National Lab., Idaho Falls, Idaho). Mar. 1968. Contract W-31-109-eng-38. 48p. Dep. CFSTI.

The control system for trace heating on EBR-II secondary sodium piping is a static, solid state scan and control system for coordinated control of 76 inductive and resistive heater circuits used for heating the secondary sodium system when reactor heat is not available. The basic control is an "ON-OFF" control. Each heater section is monitored for temperature and is protected through a high- and low-temperature alarm system. (auth)

50699 (ANL–7487) REACTOR DEVELOPMENT PROGRAM. Progress Report, August 1968. (Argonne National Lab., Ill.). Sept. 26, 1968. Contract W-31 109-eng-38. 112p. Dep. CFSTI.

Highlights of project activities are summarized for the month of August 1968. Fuel development programs for the LMFBR are described. Operations of the ZPR-3 Assembly 51 and 52 for LMFBR physics developments during August 1968 are described. Loading and startup programs of the ZPPR are presented. Operations for the EBR-2 during August 1968 are described. Nuclear safety studies, including TREAT operations, and chemical separation activities are discussed. (D.C.C.)

50700 (APDA-CFE–22) COMPILATION OF CURRENT TECHNICAL EXPERIENCE AT ENRICO FERMI ATOMIC POWER PLANT, MAY 1968. Costello, R. H. (Atomic Power Development Associates, Inc., Detroit, Mich. Power Reactor Development Co., Detroit, Mich. Detroit Edison Co., Mich.). Aug. 1968. Contract AT(11-1)-865. 37p. Dep. CFSTI.

Tools and methods for removal of the zirconium screw heads which fasten the zirconium segments to the conical flow guide in the reactor core inlet plenum are described. Operations and maintenance requirements for the months of May 1968 are described. (D.C.C.)

50701 (APED–5458) EFFECTIVENESS OF CORE STANDBY COOLING SYSTEMS FOR GENERAL ELECTRIC BOILING WATER REACTORS. Ianni, P. W. (General Electric Co., San Jose, Calif. Atomic Power Equipment Dept.). Mar. 1968. 86p. Dep.

The performance of the core standby cooling systems used for core cooling following a postulated loss-of-coolant accident in a 1967 General Electric Product-Line Boiling Water Reactor is described and analyzed as a function of break size. The test programs which have been conducted to obtain significant design parameters related to these systems are also discussed. It is concluded that the core standby cooling network provides an effective means in depth of terminating the core heatup transient over the complete spectrum of loss-of-coolant accidents up to the double-ended rupture of the main recirculation pipe. (auth)

50702 (BNWL–849) COVER GAS IMPURITIES IN SODIUM-COOLED REACTORS: LITERATURE SURVEY. Maffei, H. P. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Aug. 1968. Contract AT(45-1)-1830. 19p. Dep. CFSTI.

A literature survey was conducted on sodium cover-gas impurities to aid the design of the FFTF cover gas system. Information on impurity levels of cover gases for 6 U. S. and 3 foreign sodium-cooled reactors is very limited, and no data were found on damage to reactor components by various impurities. Data from laboratory tests show a possible nitriding effect of nitrogen cover gas on austenitic stainless steels. 22 references. (H.D.R.)

50703 (DOCKET-50231–21) SOUTHWEST EXPERIMENTAL FAST OXIDE REACTOR. Facility Description and Safety Analysis Report, Amendment 19, Suppl. 19 and Suppl. 20. (General Electric Co., Sunnyvale, Calif. Advanced Products Operation). Sept. 27, 1968. 233p. Dep. CFSTI.

On-site decontamination procedures for the Southwest Experimental Fast Oxide Reactor are given. On-site and off-site medical treatment under emergency conditions is described. Reflector control system modifications are discussed. Effects of loss of external power because of tornadoes are analyzed. Design details and SEFOR use of the Fast Reactivity Excursion Device (FRED) are included. Dynamic loadings of the core support structure during the planned-prompt transient test program are evaluated. Design and installation of the thermal insulation on the core support shroud is discussed. Detailed meteorological data are given. (M.L.S.)

50704 (DOCKET-50231–22) SOUTHWEST EXPERIMENTAL FAST OXIDE REACTOR. [Facility Description and Safety Analysis Report], Amendment 20. (General Electric Co., Sunnyvale, Calif. Advanced Products Operation). Sept. 30, 1968. 3p. Dep. CFSTI.

The request for permission to load fuel into the Southwest Experimental Fast Oxide Reactor (SEFOR) is given; this includes initial low power operation (<1 MW), also. (M.L.S.)

50705 (DOCKET-50231–23) SOUTHWEST EXPERIMENTAL FAST OXIDE REACTOR. [Facility Description and Safety Analysis Report], Amendment 21. (General Electric Co., Sunnyvale, Calif. Advanced Products Operation). Oct. 1, 1968. 122p. Dep. CFSTI.

A detailed emergency plan for the Southwest Experimental Fast Oxide Reactor (SEFOR) is given. Detailed procedures and an action guide are included. (M.L.S.)

50706 (DOCKET-50244–4) ROBERT EMMETT GINNA NUCLEAR POWER PLANT, UNIT NO. 1. Final Facility Description and Safety Analysis Report, Suppl. 3, Exhibit D-7. (Rochester Gas and Electric Corp., N. Y.). Sept. 6, 1968. 104p. Dep. CFSTI.

Detailed information on the design of large opening reinforcements for the containment vessel for Robert E. Ginna Power Reactor, Unit 1 is given. The following general categories of information are detailed: design bases, general description of opening reinforcement, stress distribution around a circular hole in a circular cylindrical shell, analysis of the stresses around large openings in the R. E. Ginna secondary containment vessel, and verification of design criteria. Appendices contain: effect of concrete creep and the sustained operating stresses on stress distribution around openings in a rapidly pressurized reinforced concrete vessel, and earthquake analysis. (M.L.S.)

50707 (DOCKET-50244–5) ROBERT EMMETT GINNA NUCLEAR POWER PLANT, UNIT NO. 1. Final Facility Description and Safety Analysis Report, Suppl. 2, Exhibit D-8. (Rochester Gas and Electric Corp., N. Y.). Sept. 30, 1968. 231p. Dep. CFSTI.

Revised information on the Robert E. Ginna Power Reactor, Unit 1, is given on the following topics: site including probable maximum flood and low water conditions; core design; cooling systems; containment systems; engineered safeguards; control systems and instrumentation; electrical systems; auxiliary and emergency systems; steam and power conversion systems; and safety analyses. (M.L.S.)

50708 (DOCKET-50293–4) PILGRIM NUCLEAR POWER STATION, PLYMOUTH, MASSACHUSETTS. (Atomic Energy Commission, Washington, D. C. Advisory Committee on Reactor Safeguards). Apr. 12, 1968. 4p. Dep. CFSTI.

The complete ACRS report on Pilgrim Power Reactor is given. (M.L.S.)

50709 (DOCKET-50293–5) PILGRIM NUCLEAR POWER STATION. [Design and Analysis Report], Amendment 2. (Boston Edison Co., Mass.). Oct. 11, 1967. 91p. Dep. CFSTI.

The research and development programs for the Pilgrim Power

Reactor are outlined. Effects of simultaneous loss-of-coolant accident and earthquake are analyzed. Bases for evaluation of the residual heat removal system are given; control system logic for the low pressure coolant injection system is described. The Emergency Core Cooling System (ECCS) operation and performance are detailed. Radiation dose effects of postulated accidents are considered. (M.L.S.)

50710 (DOCKET-50293-7) PILGRIM NUCLEAR POWER STATION. [Design and Analysis Report], Amendment 3. (Boston Edison Co., Mass.). Dec. 20, 1967. 160p. Dep. CFSTI.

Supplementary site analyses for the Pilgrim Power Reactor are given. Detailed information is given on: geology, engineering seismology, and foundation investigation. Appendices include all consultants reports. (M.L.S.)

50711 (DOCKET-50293-8) PILGRIM NUCLEAR POWER STATION. [Design and Analysis Report], Amendment 4. (Boston Edison Co., Mass.). Dec. 28, 1967. 245p. Dep. CFSTI.

Design bases for Pilgrim Power Reactor are given. Storm-tide heights at Rocky Point, Massachusetts, the Pilgrim site, are analyzed in detail; comparisons of effects of hurricanes and Northeasters for northern New England are given. The oceanographic investigation program is detailed. Various aspects of the designs for the buildings at the Pilgrim site are considered; loading combinations, stress or deformation limits, and design safety margins are given. An outline of the quality control program for component fabrication and installation construction is included. Functions of the onsite and offsite electrical systems are discussed. The General Electric Nuclear Power Plant Training Program is included. (M.L.S.)

50712 (DOCKET-50293-10) PILGRIM NUCLEAR POWER STATION. [Design and Analysis Report], Amendment 5. (Boston Edison Co., Mass.). Feb. 6, 1968. 115p. Dep. CFSTI.

Supplementary information on the Pilgrim Power Reactor site is given; this includes both geology and seismology information. A parametric study of the residual heat removal heat exchanger is included. Operation of the Emergency Core Cooling System is analyzed. Design criteria for Class I systems are discussed. Integrity of secondary containment under tornado loadings is evaluated. The low pressure coolant injection system is described. Radiation monitoring equipment and ranges are described; typical locations and sensitivity for area monitors are tabulated. (M.L.S.)

50713 (DOCKET-50293-11) PILGRIM NUCLEAR POWER STATION. [Design and Analysis Report], Amendment 7. (Boston Edison Co., Mass.). Mar. 11, 1968. 14p. Dep. CFSTI.

Supplementary information on the soils investigations at the Pilgrim Power Reactor site are given. (M.L.S.)

50714 (DOCKET-50293-12) PILGRIM NUCLEAR POWER STATION. [Design and Analysis Report], Amendment 8. (Boston Edison Co., Mass.). Mar. 11, 1968. 14p. Dep. CFSTI.

Seismic analyses for the Pilgrim Power Reactor site are given. Information is included on: no loss of function criteria for Class I concrete structures, no loss of function criteria for Class I ductile metallic equipment and structures, seismic analysis, damping values, Class I piping, and main control panels. (M.L.S.)

50715 (DOCKET-50293-13) PILGRIM NUCLEAR POWER STATION. [Design and Analysis Report], Amendment 9. (Boston Edison Co., Mass.). Mar. 11, 1968. 23p. Dep. CFSTI.

The requirements for the Emergency Core Cooling Systems (ECCS) for Pilgrim Power Reactor are detailed. Strain limit criteria used in accident analyses are defined. The details of the low pressure coolant injection system are given. (M.L.S.)

50716 (DOCKET-50293-14) [PILGRIM NUCLEAR POWER STATION]. [Design and Analysis Report], Amendment 11. (Boston Edison Co., Mass.). Apr. 3, 1968. 5p. Dep. CFSTI.

Financial data on the Boston Edison Company, owners of the Pilgrim Power Reactor, is given. (M.L.S.)

50717 (DOCKET-50293-15) PILGRIM NUCLEAR POWER STATION. Design and Analysis Report, Vol. 1. (Boston Edison Co., Mass.). June 23, 1967. 450p. Dep. CFSTI.

Information on Pilgrim Power Reactor is given under the following broad topics: Introduction and Summary; Station Site and Environs; Reactor Core; Reactor Coolant System; Station Containment Systems; Station Engineered Safeguards; Station Radioactive Waste Control Systems; Station Electrical Power Systems; and Station Instrumentation and Control Systems. (M.L.S.)

50718 (DOCKET-50293-16) PILGRIM NUCLEAR POWER STATION. Design and Analysis Report, Vol. 2. (Boston Edison Co., Mass.). June 30, 1967. 309p. Dep. CFSTI.

Information on Pilgrim Power Reactor is given under the following broad topics: Reactor Auxiliary, Station Service, and Station Cooling Systems; Station Structures; Station Operations; and Station Safety and Accident Analyses. Appendices include: reactor core spray cooling system test program, containment fission product retention capability, control rod drive system description and analysis, and jet pump development program. (M.L.S.)

50719 (DOCKET-50293-17) PILGRIM NUCLEAR POWER STATION. Design and Analysis Report, Vol. 3. (Boston Edison Co., Mass.). June 30, 1967. 180p. Dep. CFSTI.

The complete set of engineering design drawings for the Pilgrim Power Reactor are included. (M.L.S.)

50720 (DOCKET-50296-4) BROWNS FERRY NUCLEAR POWER PLANT, UNIT 3, LIMESTONE COUNTY, ALABAMA. License Application. (Tennessee Valley Authority, Knoxville). July 17, 1967. 89p. Dep. CFSTI.

The license application for Browns Ferry Power Reactor, Unit 3 is given. Financial qualifications of TVA, owner of the Browns Ferry Reactors, are given; the Power Quarterly Report for the nine months ended March 31, 1967 is attached. The Power Annual Report for the fiscal year ended June 30, 1966 is included. (M.L.S.)

50721 (DOCKET-50296-5) BROWNS FERRY NUCLEAR POWER STATION, UNIT NO. 3. Provisional Construction Permit, CPPR-48. (Division of Reactor Licensing (AEC), Washington, D. C.). July 31, 1968. 3p. Dep. CFSTI.

The record of issuance of Provisional Construction Permit No. CPPR-48 to TVA for construction of Browns Ferry Power Reactor, Unit 3 is given. (M.L.S.)

50722 (DOCKET-50296-6) BROWNS FERRY NUCLEAR POWER STATION, UNIT 3. Design and Analysis Report, Amendment 2. (Tennessee Valley Authority, [Knoxville]). Feb. 29, 1968. 166p. Dep. CFSTI.

A complete analysis of tornado loadings of the Browns Ferry Power Reactor, Unit 3 is given. Emergency core cooling pump location is considered; the toroidal suppression chamber is described. Those systems which will be designed to Class I seismic criteria are tabulated. Sizing of diesel generators is discussed. The on-site electric system is detailed; schematics are included. Diesel generator capability is discussed; reliability factors are outlined. The diesel generator fuel oil system and air starting system are discussed. Detailed descriptions are given of the emergency equipment cooling water system, residual heat removal service water system, and the reactor building closed cooling water system. Plant operation following loss of off-site power is outlined. The philosophy behind the design approach for shared systems is given. (M.L.S.)

50723 (DOCKET-50296-7) BROWNS FERRY NUCLEAR POWER STATION, UNIT 3. Design and Analysis Report, Amendment 3. (Tennessee Valley Authority, [Knoxville]). Mar. 4, 1968. 81p. Dep. CFSTI.

Comparison of the Browns Ferry Power Reactor, Unit 3, with the General Design Criteria is tabulated. The design criteria for Class I structures are given. Detailed information on the expected performance of the Emergency Core Cooling System is given. (M.L.S.)

50724 (DOCKET-50296-8) BROWNS FERRY NUCLEAR POWER STATION, UNIT 3. Design and Analysis Report, Amendment 5. (Tennessee Valley Authority, [Knoxville]). Apr. 22, 1968. 34p. Dep. CFSTI.

The quality control programs, instituted by the TVA for Browns Ferry Power Reactor, Unit 3, are outlined. Parallel operation of diesel generators is analysed. (M.L.S.)

50725 (DOCKET-50313-12) RUSSELLVILLE NUCLEAR UNIT. Preliminary Safety Analysis Report, [Amendment 10], Suppl. 10. (Arkansas Power and Light Co., Little Rock). Sept. 6, 1968. 41p. Dep. CFSTI.

Financial statements, including balance sheets as of December 31, 1967 and July 31, 1968, of Arkansas Power and Light Company, owners Russellville Power Reactor, are given. Personnel information is updated, also. (M.L.S.)

50726 (DOCKET-50317-6) CALVERT CLIFFS NUCLEAR POWER PLANT, UNITS 1 AND 2. Preliminary Safety Analysis Report, Amendment 3. (Baltimore Gas Electric Co., Md.). Sept. 24, 1968. 219p. (DOCKET-50318-6). Dep. CFSTI.

Supplemental information is given on Calvert Cliffs Power Reactor, Units 1 and 2, under the following topics: prevention of brittle fracture in the primary cooling system; containment system construction materials, including steel prestressing tendons and steel liner plate, and containment design bases; containment

isolation system and penetrations; descriptions of chemical and volume control system and component cooling system; quality assurance program; complete loss-of-coolant analysis and containment structure pressure analysis; and detailed soil analyses including test data. (M.L.S.)

50727 (DOCKET-50322-6) SHOREHAM NUCLEAR POWER STATION, [UNIT 1]. [Preliminary Safety Analysis Report], Amendment 2. (Long Island Lighting Co., Mineola, N. Y.). Sept. 26, 1968. 104p. Dep. CFSTI.

Revised information is given on all systems of the Shoreham Power Reactor. Drawings, calculations and calculational models, and descriptive material are included. (M.L.S.)

50728 (GA-8268) GAS-COOLED FAST REACTOR PERFORMANCE WITH VARIOUS DEGREES OF SURFACE ROUGHENING. Melese-d'Hospital, Gilbert B. (Gulf General Atomic, Inc., San Diego, Calif.). Oct. 2, 1967. Contract AT(04-3)-167. 48p. Dep. CFSTI.

The optimum degree of partial surface roughening corresponds approximately to doubling the heat transfer coefficient with respect to smooth surfaces (while the friction factor is tripled) when both maximum surface and internal fuel temperatures are given. The maximum power per unit length of fuel element increases nearly linearly with the difference between maximum clad and maximum coolant temperatures: the coefficient of proportionality is found to depend mostly upon the degree of surface roughening. Gas-Cooled Fast Reactors are found to have very good performance and low fuel cycle costs for a large range of such parameters as degree of roughening, core shape, maximum clad temperature and maximum linear rating, by properly adjusting coolant temperatures. (auth)

50729 (GA-8564) FIPER-I: A FORTRAN IV PROGRAM FOR THE RELEASE OF FISSION PRODUCTS FROM A HIGH-TEMPERATURE GAS-COOLED NUCLEAR POWER REACTOR. Roos, B. W.; Welch, J. E. (Gulf General Atomic, Inc., San Diego, Calif.). May 2, 1968. Contract AT(04-3)-167. 131p. Dep. CFSTI.

A description of the FORTRAN 4 computer code FIPER-1 is presented. The code, based on the theoretical formulation of Appel and Roos, computes the temperature and concentration induced, transient and steady-state, diffusion of fission product isotopes in one-dimensional slab geometry. The code computes the release rates of metallic fission products from the core of a high-temperature gas-cooled nuclear power reactor. (auth)

50730 (GEAP-4221) RESIDUAL STRESS AND STRESS-CORROSION CRACKING OF TYPE-304 STAINLESS STEEL FUEL CLADDING. Lees, E. A.; Denison, W. L.; Hazel, V. E. (General Electric Co., San Jose, Calif. Nuclear Fuels Dept.). May 1968. Contract AT(04-3)-361. 30p. Dep. CFSTI.

The results of residual stress measurements on archive cladding from Big Rock Point Power Reactor developmental fuel assemblies PO-1 to PO-4 are presented. Also presented are the results of residual stress and stress-corrosion cracking susceptibility of Type 304 stainless steel used in the High Power Density Project, Vallecitos Boiling Water Reactor irradiations. (auth)

50731 (GEAP-5556) IN-PILE COMPARISON OF EFFECTIVE THERMAL CONDUCTIVITY OF (PuO_2-UO_2) MIXED OXIDES. Craig, C. N.; Baily, W. E. (General Electric Co., Sunnyvale, Calif. Advanced Products Operation). Nov. 1967. Contract AT(04-3)-189. 56p. Dep. CFSTI.

The effect of changes in stoichiometry and density on the effective thermal conductivity and microstructure of plutonium-uranium mixed oxide fuels irradiated at high ratings (27 to 36 kW/ft) are described and compared with similar UO_2 data. Calculated values for the integrated thermal conductivity of $(Pu_{0.2}U_{0.8})O_2$ fuel of 1.98 and 2.00 stoichiometry are presented. (auth)

50732 (GEAP-5631) SODIUM-COOLED REACTORS: FAST CERAMIC REACTOR DEVELOPMENT PROGRAM. Twenty-sixth Quarterly Report, February-April 1968. (General Electric Co., Sunnyvale, Calif. Advanced Products Operation). June 1968. Contract AT(04-3)-189. 121p. Dep. CFSTI.

FAST CERAMIC REACTOR — fuel development performance testing during February to April 1968, analysis of plutonium oxide (PuO_2)-uranium oxide (UO_2); core configuration for, development of optimum economic

REACTOR FUEL ELEMENTS — cladding defects for plutonium oxide (PuO_2)-uranium oxide (UO_2), effects of annealing and cold-working on Type 316 stainless steel; fission product release from sodium-bonded Type 347 and Type 316 stainless steel-clad plutonium oxide (PuO_2)-ur..nium oxide (UO_2), testing of; compatibility of Type 316 stainless steel-clad sodium-bonded plutonium oxide (PuO_2)-uranium oxide (UO_2), analysis of interface; melting failure of plutonium oxide (PuO_2)-uranium oxide (UO_2), effects of power transients on; thermal conductivity of Type 347 and Type 316 stainless steel-clad plutonium oxide (PuO_2)-uranium oxide (UO_2), analysis of; burnup performance of Type 316 stainless steel-clad plutonium oxide (PuO_2)-uranium oxide (UO_2), analysis of 125,000 MWd/Te; fission product distribution in Incoloy 800-clad and Type 316 and Type 347 stainless steel-clad plutonium oxide (PuO_2)-uranium oxide (UO_2), analysis of

STAINLESS STEEL — cladding defects in Type 316, effects of annealing and cold-working on; cladding performance of Type 316 and Type 347, analysis of plutonium oxide (PuO_2)-uranium oxide (UO_2) sodium-bonded fuel element fission product release effects on; cladding compatibility of Type 316, analysis of sodium-bonded plutonium oxide (PuO_2)-uranium oxide (UO_2) fuel element; cladding thermal conductivity of Type 316 and Type 347, analysis of plutonium oxide (PuO_2)-uranium oxide (UO_2) fuel element; cladding performance of Type 316, analysis of plutonium oxide (PuO_2)-uranium oxide (UO_2) fuel element 125,000 MWd/Te burnup; cladding performance of Type 316 and Type 347; analysis of plutonium oxide (PuO_2)-uranium oxide (UO_2) fuel element fission product distribution effects on; radiation effects on tensile properties of Type 304, Type 316, Type 321, and Type 347, analysis of fast neutron

PLUTONIUM OXIDES PuO_2 — PuO_2-UO_2, fission product release from Type 316 and Type 347 stainless steel-clad sodium-bonded, analysis of; PuO_2-UO_2, compatibility of sodium-bonded Type 316 stainless steel-clad, analysis of interface; PuO_2-UO_2, melting failure of, effects of power transients on fuel element; PuO_2-UO_2, thermal conductivity of Type 316 and Type 347 stainless steel-clad, analysis of; PuO_2-UO_2, burnup performance of Type 316 stainless steel-clad, analysis of 125,000 MWd/Te; PuO_2-UO_2, fission product distribution in Incoloy 800-clad and Type 316 and Type 347 stainless steel-clad, analysis of

INCOLOY 800 — cladding performance of, analysis of plutonium oxide (PuO_2)-uranium oxide (UO_2) fuel element fission product distribution effects on; radiation effects on tensile properties of, analysis of fast neutron

SODIUM — compatibility of Type 316 stainless steel-clad plutonium oxide (PuO_2)-uranium oxide (UO_2) fuel elements bonded with, analysis of interface

URANIUM OXIDES UO_2 — mechanical properties of, description of

NEUTRONS, FAST — effects on tensile properties of Incoloy 800 and Type 304, Type 316, Type 321, and Type 347 stainless steel, analysis of (D.C.C.)

50733 (GEAP-5635) SIGNIFICANCE OF NEUTRON DATA UNCERTAINTIES TO FAST REACTOR ECONOMICS AND POWER PLANT DESIGN. Greebler, P.; Hutchings, B. A.; Linford, R. B.; Wolfe, B. (General Electric Co., Sunnyvale, Calif. Advanced Products Operation). June 1968. Contract AT(04-3)-189. 24p. Dep. CFSTI.

An evaluation of the sensitivity of physics parameters and fuel costs of fast power reactors indicates that combined current data uncertainties produce about a ±0.15 mill/kWh uncertainty in fuel cost for a sodium-cooled, fast reactor whose design has not been severely limited by requirements on the sodium void and Doppler reactivity effects. For a reactor that must satisfy stringent sodium void and Doppler reactivity requirements, the combined data uncertainties produce about a ±0.25 mill/kWh uncertainty in fuel cost. The current large uncertainty in the Pu-239 alpha value below 15 keV is the largest single contributor to the overall fuel cost uncertainty, with the uncertainties in U-238 radiative capture cross sections and Pu-239 $\bar{\nu}$ being next in importance. A set of targets for nuclear data accuracy is recommended, on the basis of the calculated sensitivity of fuel cost to specific data uncertainties, which would reduce the calculated fuel cost uncertainty to about ±0.03 mill/kWh. Design modifications and associated development programs to improve fuel and heat transfer-fluid flow performance will be required for sodium-cooled, fast reactors in the event of appreciably adverse nuclear data, if specific performance targets, such as low fissile doubling time (~10 years), are to be achieved. The uncertainties in performance, date of introduction, and need for additional development of fast reactors because of data uncertainties have large enough economic implications for the total reactor economy to justify an intensive effort to reduce these uncertainties. (auth)

50734 (GEAP-5637) REACTOR PRIMARY COOLANT SYSTEM RUPTURE STUDY. Quarterly Progress Report No. 12, January-March 1968. (General Electric Co., San Jose, Calif. Atomic Power Equipment Dept.). June 1968. Contract AT-(04-3)-189. 142p. Dep. CFSTI.

PIPES — crack growth in metal, equation derivation for proba-

bility of circumferential, (T); elbows in, computer program for stress analysis of; fracture mechanics of ASTM A-106B steel, analysis of

CARBON STEEL— crack growth in, effects of temperature and stress on low-cycle fatigue; crack growth in multiple configuration, three-dimensional photoeleastic analysis of; tensile properties of, effects of temperature on; crack growth in, effects of boiling water environment on

STAINLESS STEEL— crack growth in Type 304, effects of temperature and stress on low-cycle fatigue; crack growth in multiple configuration, three-dimensional photoelastic analysis of; crack growth in Type 304, effects of cycles and strain range on low-cycle fatigue; crack growth in Type 304, effects of boiling water environment on

STEEL— Cr–Mo– steel, crack growth in, effects of temperature and stress on low-cycle fatigue; crack growth in multiple configuration low alloy, three-dimensional photoelastic analysis of; fracture mechanics in pipes of ASTM A-106B, analysis of; crack growth in ASTM A-212B, effects of cycles and strain range on low-cycle fatigue; Cr–Mo– steel, crack growth in, effects of cycles and strain range on low-cycle fatigue (D.C.C.)

50735 (GEAP–5648) SODIUM COMPONENTS DEVELOPMENT PROGRAM. MASS TRANSFER INVESTIGATIONS IN LIQUID METAL SYSTEMS. Quarterly Progress Report No. 5, March–May 1968. (General Electric Co., Sunnyvale, Calif. Advanced Products Operation). July 1968. Contract AT-(04-3)-189. 76p. Dep. CFSTI.

Work is reported on investigations of materials corrosion, mechanical properties, and sodium impurities in pumped sodium systems operating under controlled purity conditions to maximum temperatures of 1300°F. Empirical equations representing hot leg corrosion measured in runs 8-1, 8-3, and 9-1 are presented for comparison. Metallurgical evaluation of results of runs 8-1 and 8-2 and metallographic examinations of high heat flux heaters were completed. Significant observations include decarburization in the 1200 to 1300°F region of an austenitic system and carburization within the same system at lower sodium temperatures, and a higher corrosion rate of Type 316 stainless steel in sodium at 1200 to 1300°F under heat transfer conditions compared to equivalent isothermal conditions. The analysis of corrosion data obtained for Types 316, 304, and 347 stainless steel and Incoloy 800 during screening tests in loops 5R and 6R is reported. The corrosion rates observed are linear. A greater rate is found for Incoloy 800 than for the austenitic grades of stainless steel. Low corrosion rates observed in the test sections for mechanical properties are attributed to low mass flow rates. It is suggested that a Reynolds Number encompassing velocity, mass flow, and hydraulic diameter should be included in further development of corrosion models. Preliminary results of examination of a cold trap from an austenitic (Type 316 stainless steel) system are given and compared to results from a cold trap from a ferritic system. A factor of three less total carbon was found in the austenitic system. The carbonate and cyanide anions were the major carbon containing forms in the residues from the ferritic system. These were reduced sevenfold in the austenitic loop deposits. A compound yielding acetylene upon hydrolysis of the ferritic loop deposits was not detected in the austenitic loop. (auth) ⊙

50736 (GEAP–5661) POWER REACTOR HIGH PERFORMANCE UO_2 PROGRAM. Progress Report No. 7, April 1–June 30, 1968. Ogawa, S. Y. (comp.) (General Electric Co., San Jose, Calif. Nuclear Fuels Dept.). July 1968. Contract AT(04-3)-189. 21p. (EURAEC–2061). Dep. CFSTI.

Work Performed under United States–Euratom Joint Research and Development Program.

Full power operation of the centermelt assemblies in the Consumers Power Company's Big Rock Point reactor was achieved on April 15, 1968. Operating power levels in the assemblies were: Advanced Performance Fuel (0.700-inch-diameter rods): 450,000 Btu/h-ft^2 (24 kW/ft) and Intermediate Performance Fuel (0.570-inch-diameter rods): 425,000 Btu/h-ft^2 (18.5 kW/ft). A definite but moderate amount of melting, up to about 22% of the fuel cross-sectional area at the peak power location, was estimated to have occurred in the larger diameter rods containing compacted powder fuel. Operation at this power level was sustained for 40 days. On May 24, reactor power was further increased about 6%. The peak heat fluxes in the Advanced and Intermediate Performance fuels were correspondingly increased to 466,000 Btu/h-ft^2 (25 kW/ft) and 430,000 Btu/h-ft^2 (18.7 kW/ft), respectively. Actual central melting in the larger diameter pellet fuel was predicted for this increased power level. The fuels have experienced two shutdown cycles and one scram cycle from central melting conditions. Operation of these assemblies through the first week in June has been satisfactory. The reactor refueling shutdown is scheduled for June 21, and preparations are being made for the first examination of these assemblies. (auth)

50737 (LA–3879) DETERMINATION OF THE SOLUBILITY OF OXYGEN IN SODIUM BY VACUUM DISTILLATION. Rutkauskas, V. J. (Los Alamos Scientific Lab., N. Mex.). July 15, 1968. Contract W-7405-eng-36. 12p. Dep. CFSTI.

The solubility of O_2 in Na was determined over the range 125 to 300°C by vacuum distillation. The temperature range was covered in increments of 10 to 25°C with a minimum of three separate determinations at each temperature level. A least-squares fit of the experimental data yielded a correlating equation of $\log_{10} y = 4.25 - 3499/T$, where y = wt % O_2. The expression gives a value for ΔH of 16,000 cal-mole^{-1}. The reproducibility of results obtained at each of the equilibrium temperature conditions was excellent, with an apparent standard deviation of 0.5 ppm in the O_2 concentration range of 1 to 10 ppm and 5% above 10 ppm. The internal consistency of the solubility results is better than that of previously published data, and the values are considerably less in the low temperature range than those shown on other solubility curves. (auth)

50738 (ORNL–4255) EVALUATION OF THE TWO-DETECTOR CROSS-CORRELATION TECHNIQUE FOR SHUTDOWN MARGIN MEASUREMENTS IN POWER REACTORS. Kryter, R. C.; Fry, D. N.; Roux, D. P. (Oak Ridge National Lab., Tenn.). Sept. 1968. Contract W-7405-eng-26. 22p. Dep. CFSTI.

The overall suitability of the two-detector cross-correlation technique (2DCT) for one-line subcriticality measurements in power reactors (fast or thermal) by inherent neutron population fluctuation analysis is examined. A conceptual on-line, "two-frequency" shutdown reactivity measurement system (employing the 2DCT as applied to the point-reactor kinetics model) is proposed. Mathematical expressions are derived which allow the quantitative prediction of attainable statistical measurement precision from the anticipated values of quantities such as subcriticality, neutron detection efficiency, neutron flux level, gamma dose rate, measurement system parameters, detector properties, and reactor neutronic parameters. Experiments are performed under simulated shutdown power reactor conditions to support basic assumptions and to validate the statistical analysis. The outlook for one-line estimation of subcriticality by "noise" analysis techniques is not found to be particularly promising. From a standpoint of statistical precision attainable within a 15-min data sampling time or less, the limited neutron detection efficiency (defined as number of neutrons detected per fission in the reactor) and the high gamma dose rate associated with system installation in a shut down power reactor are found to have an extremely adverse effect on the measurement capability. From a standpoint of engineering practicality, the necessity of locating the detectors in the immediate vicinity of the reactor core (thereby subjecting them to a high-temperature high-radiation environment when the reactor operates at power) is found to present serious obstacles to the installation of a workable hardware system. It is concluded that subcriticality inference by 2DCT neutron fluctuation analysis is most suitable to those power reactors which have large inherent neutron sources and/or low fission product gamma dose rates, shutdown margins of less than ~5 dollars, and large-volume neutron detectors installed in close proximity to the reactor core.

50739 (ORNL-NSIC–22) MISSILE GENERATION AND PROTECTION IN LIGHT-WATER-COOLED POWER REACTOR PLANTS. Gwaltney, Richard C. (Oak Ridge National Lab., Tenn.). Sept. 1968. Contract W-7405-eng-26. 65p. Dep. CFSTI.

The state of current technology of missile generation and protection in relation to the capability of meeting the relevant design criteria for nuclear power plants is presented. As part of the current technology, practices in other industries are discussed, and the available calculational techniques and their bases and deficiencies are described. A general description is also included of the cause and nature of shock waves, the various kinds of missiles that could be generated in the event of rupture of a primary system vessel, and the considerations involved in designing to protect against the harmful effects of shock waves and missiles. A summary of the current practice for nuclear power reactor designs is given, gaps in the relevant current technology are discussed, and recommendations are made for further research and development in this field. 83 references. (auth)

50740 (TRG-Inf.-Ser.–678) NUCLEAR POWER REACTOR ENGINEERING SELECTED AND ANNOTATED REFERENCES. Hartas, J. C.; Sharp, J. C. C. (comps.) (United Kingdom Atomic Energy Authority, Risley (England). Reactor Group). 1968. 18p. (IGRL-IB/R–6(4th Ed.)). Dep. CFSTI. UK 2s. 6d.

A selection of 112 books in English for people wanting either an introduction to, or a list of standard works covering, the general field of nuclear power reactor engineering is presented. All are

readily available, either commercially or through public and other large libraries. Arranged in 5 broad subject groups, the bibliography excludes operations not strictly the concern of the reactor engineer (e.g., fuel reprocessing, waste disposal etc.) but includes references on metallurgy, fuel fabrication, corrosion, etc., containing information of interest to him. A few major symposia have been issued in periodicals rather than in books, and these are included because of their importance. (auth)

50741 (WASH-1083) AN EVALUATION OF HEAVY-WATER-MODERATED ORGANIC-COOLED REACTORS. (Oak Ridge National Lab., Tenn.). Mar. 1968. 183p. GPO $1.50.

REACTORS, HEAVY WATER-MODERATED—development program for 1000 MW(e) organic-cooled, description of
REACTORS, ORGANIC-COOLED—development program for 1000 MW(e) heavy water-moderated, description of
REACTORS, POWER—development program for 1000 MW(e) heavy water-moderated organic-cooled, description of
REACTOR FUELS—effects on physics characteristics of 1000 MW(e) heavy water-moderated organic-cooled power reactors, analysis of
URANIUM CARBIDES, URANIUM ALLOYS AND SYSTEMS—fuel for 1000 MW(e) heavy water-moderated organic-cooled power reactors of natural and enriched, economic and technical analysis of
THORIUM ALLOYS AND SYSTEMS, URANIUM ALLOYS AND SYSTEMS—Th-U, fuel for 1000 MW(e) heavy water-moderated organic-cooled power reactors of, economic and technical analysis of
THORIUM OXIDES ThO_2, URANIUM OXIDES UO_2—ThO_2-UO_2, fuel for 1000 MW(e) heavy water-moderated organic-cooled power reactors of, economic and technical analysis of
REACTOR FUEL ELEMENTS—assemblies for 1000 MW(e) heavy water-moderated organic-cooled power reactor, analysis of optimum
REACTIVITY—power distribution for core configurations of 1000 MW(e) heavy water-moderated organic-cooled power reactors, analysis of optimum radial
HEAT TRANSFER SYSTEMS—configurations of 1000 MW(e) heavy water-moderated organic-cooled power reactors, analysis of optimum
SAP (SINTERED ALUMINUM POWDERS), ZIRCALOY-2—cladding for 1000 MW(e) heavy water-moderated organic-cooled power reactors fuel elements of, performance analysis of
POLYPHENYL SYSTEMS—coolants of Santowax OM, WR, and OMP, performance analysis for heavy water-moderated organic-cooled 1000 MW(e) power reactors
TERPHENYL—coolant of HB-40, performance analysis for heavy water-moderated organic-cooled 1000 MW(e) power reactors
REACTOR CONTROL SYSTEMS—operation of 1000 MW(e) heavy water-moderated organic-cooled power reactor, description of optimum
REACTOR CONTROL ELEMENTS—performance of 1000 MW(e) heavy water-moderated organic-cooled power reactor, analysis of optimum (D.C.C.)

50742 (WCAP-2240) 1000 MWE SUPERCRITICAL PRESSURE NUCLEAR POWER PLANT DESIGN STUDY. (Westinghouse Electric Corp., Pittsburgh, Pa. Atomic Power Div.). Jan. 1964. Contract AT(30-1)-2948. 391p. Dep. CFSTI.

A conceptual design is presented for a 1000 MW(e) Supercritical Once-Thru Tube Reactor (SCOTT-R). Economic and technical feasibility objectives are discussed. (D.C.C.)

50743 (WCAP-3385-16) SAXTON PLUTONIUM PROGRAM. Semiannual Progress Report for the Period Ending June 30, 1968. (Westinghouse Electric Corp., Pittsburgh, Pa. Atomic Power Div.). Aug. 1968. Contract AT(30-1)-3385. 28p. (EURAEC-2043). Dep. CFSTI.

Work performed under United States–Euratom Joint Research and Development Program.

SAXTON POWER REACTOR—fuel elements in, comparison of experimental and calculated performance values for plutonium; power distributions in, comparison of calculated and measured values for; fuel elements for, overpower testing of
REACTOR FUEL ELEMENTS—performance in Saxton Power Reactor of plutonium, evaluation of experimental and theoretical; burnup distribution in Saxton plutonium, calculation of
BORON—poisoning in Saxton plutonium fuel elements, determination of reactivity worth of
REACTIVITY—worth determination for boron poisoning in Saxton Power Reactor fuel elements. (M.L.S.)

50744 (ZJE-23) STUDY OF SHORT-LIVED SPATIAL REACTOR KINETICS. Jurecka, Jaroslav (SKODA Works, Pilsen (Czechoslovakia)). [1967]. 50p. Dep.

The spatially dependent kinetic equations for the multiregion reactor are studied. The modal method used is limited by the same assumptions inherent in the diffusion theories and by mathematical approximation used in representing the space-time reactor functions. The solution of the critical case is presented. The convergence of the criticality parameter H and of the slow flux for the A – 1 reactor as a function of the number of modes is shown and it is compared with the previous results. The concept of a transfer function for a nuclear system is extended to include spatial effects. Theoretical curves calculated for the A – 1 reactor are compared with the currently used lumped-parameter transfer function. (auth)

50745 (ZJE-24(Pt.1)) DISTRIBUTION OF THERMAL NEUTRON FLUX IN HWGCR LATTICE CELL. PART 1. SPACE DISTRIBUTION OF NEUTRON FLUX. Lehmann, Miroslav (SKODA Works, Pilsen (Czechoslovakia)). [1967]. 63p. Dep.

The method of solution of one group transport equation for equivalent cylindrical cell of HWGCR lattice is analyzed. The method represents the combination of diffusion method in moderator region with that one of integral transport in fuel element. A special attention is devoted to inclusion of the influence of cluster structure on neutron flux distribution in fuel element. The applications of this theory are one group codes PROTĚŽ T1 and T1A, a short description of which is presented. (auth)

50746 (ZJE-25) SOME ECONOMICAL ASPECTS OF FUEL CYCLE IN CZECHOSLOVAKIA. Hulka, Ivan (SKODA Works, Pilsen (Czechoslovakia)). June 1968. 14p. Dep.

The U fuel requirements and costs for production of electricity by nuclear power plants in Czechoslovakia are estimated for the period from 1970 to 1990. The estimates are based on plants of 500 or 1000 MW(e) capacity utilizing pressurized heavy water reactors fueled with natural U and boiling water reactors fueled with enriched uranium. (H.D.R.)

50747 (ZJE-26) PROSPECT OF THE HEAVY WATER REACTOR DEVELOPMENT IN CZECHOSLOVAKIA. Hulovec, Jan (Skoda Works, Pilsen (Czechoslovakia). Nuclear Power Plant Div.). June 1968. 14p. Dep.

The various factors that influenced the selection of heavy water reactors as the type for use in the first Czechoslovakian nuclear power plants are reviewed, and the results of a comparative study of 4 heavy water reactor concepts of 500 MW(e) are presented. Selected technical parameters are tabulated for the 150 MW(e) nuclear power station A-1, which is under construction, and for the planned 330 MW(e) station A-2. (H.D.R.)

50748 (ZJE-27) RADIATION DAMAGE AND SURVEILLANCE PROGRAMS FOR CZECHOSLOVAK REACTOR STEEL PRESSURE VESSELS. Brumovsky, Milan (Skoda Works, Pilsen (Czechoslovakia). Nuclear Power Plant Div.). July 1968. 24p. Dep.

Neutron radiation effects and temperature effects on the mechanical properties of Al–Ni–steel–Ti and Mn–Mo–Nb–Ni–steel are analyzed. The steels are possible pressure vessel materials for the Bohunice Power Reactor, Unit 1. Testing procedures and results are described. (D.C.C.)

50749 COMING AGE OF NUCLEAR ENERGY. Weinberg, Alvin M. (Oak Ridge National Lab., Tenn.). Kernenergie, 11: 181-6(July 1968).

A brief review of nuclear power production in the U. S., France, and United Kingdom is presented. The development of a water-cooled reactor agro-industrial complex is discussed. (D.C.C.)

50750 CERAMIC FUEL FABRICATION IN THE U.K.A.E.A. Allday, C.; Dalley, P. (United Kingdom Atomic Energy Authority, Risley, Eng.). pp 416-33 of Fabrication of Ceramic Type Power Reactor Fuel Elements. VIII Nuclear Congress, Rome, 19–20 June 1963. Roma, Comitato Nazionale Energia Nucleare, 1967.
See CONF-193-(Vol.1).

A detailed description of techniques used in the production of stainless steel-clad enriched UO_2 fuel elements and assemblies for the windscale AGR includes tables of design parameters and flow sheets for the manufacture of UO_2 pellets, fuel element loading, and fuel element assembly. Plant safety precautions are discussed. (P.G.C.)

50751 THE DESIGN AND FABRICATION OF THE SELNI FIRST CORE. Russo, H. L. (Westinghouse Electric Corp., Selni, Italy); d'Arminio, G.; Casini, R. pp 83-92 of Fabrication of Ceramic Type Power Reactor Fuel Elements. VIII Nuclear Congress, Rome, 19–20 June 1963. Roma, Comitato Nazionale Energia Nucleare, 1967.
See CONF-193-(Vol.1).

Modifications and improvements made in the Selni closed-cycle water reactor core are described. Mechanical and nuclear design factors are discussed, as are manufacture of UO_2 powder, pellet-

ization, sintering, fuel rod assembly, fuel assembly loading, quality control, and inspection methods. (P.G.C.)

50752 NUCLEAR TESTS AT ZERO POWER OF THE GARIGLIANO SENN–GE REACTOR. Galliani, Marcello (Societa Elettro Nucleare Nazionale, Rome). pp 455-61 of Fisica del Reattore. Rome, Consiglio Nazionale delle Ricerche, 1966. (In Italian).

From Conference on Physics of Reactors, Milan. See CONF-469.

Zero-power testing of the Garigliano Power Reactor is described. Each test is discussed, briefly. Kinetic and dynamic characteristics are summarised. (M.L.S.)

50753 MEASUREMENT OF THE TEMPERATURE COEFFICIENT OF A GAS COOLED REACTOR. COMPARATIVE EXAMINATION OF THE MEASUREMENTS CARRIED OUT ON THE LATINA REACTOR. La Parola, Gian Guido Lesnoni; Marzullo, Tommaso (ENEL, Latina, Italy). pp 549-61 of Fisica del Reattore. Rome, Consiglio Nazionale delle Ricerche, 1966. (In Italian).

From Conference on Physics of Reactors, Milan. See CONF-469.

Measurement of temperature coefficient of reactivity is discussed; the various methods are considered briefly. A description of the measurements performed in the Latina Power Reactor is given. The experimental data obtained in the Latina measurements are discussed. (M.L.S.)

50754 CALCULATION OF THE TEMPERATURE COEFFICIENT IN HETEROGENEOUS THERMAL REACTORS. Forti, Guido (CNEN, Rome). pp 685-91 of Fisica del Reattore. Rome, Consiglio Nazionale delle Ricerche, 1966. (In Italian).

From Conference on Physics of Reactors, Milan. See CONF-469.

Calculation of the temperature coefficient of reactivity for thermal heterogeneous reactors is discussed. The mathematical expression for the overall Doppler coefficient is given; expressions for the thermal spectrum and average cross section are developed. Comparisons of experimental and calculated disadvantage factors for heavy water and light water lattices are tabulated. (M.L.S.)

50755 DEVICE FOR PREVENTING THE PRESSURE INCREASE IN AN EMERGENCY ACCIDENT. Sugino, Shigemi (to Hitachi Ltd.). Japanese Patent 1967-22865. Dec. 25, 1967. Filed Apr. 7, 1965.

Utilizing the ejector-condenser principle and combined spray and pressure-suppression, the method increases the condensation of released vapor and prevents an internal peak pressure. The result is a small reactor containment vessel and a reduction of the power generation cost. The system consists of the following: the reactor containment vessel containing the reactor pressure vessel; pressure-suppression chambers connected to the containment vessel at the bottom through vent pipes; a header in the lower part of the containment vessel with ejectors which open toward the vents; and, an ejector spray in the upper part of the containment vessel. By this means the condensation of vapor at the time of a reactor accident is increased. (NSA of Japan)

50756 DEVICE FOR PREVENTING THE INUNDATION OF THE SUPERHEATING SECTION OF THE REACTOR CORE. Azuma, Masao (to Hitachi Ltd.). Japanese Patent 1967-22859. Dec. 25, 1967. Filed Dec. 1, 1964.

By the method proposed, the inundation of the central superheating section from the surrounding boiling section can be prevented. Extending upward and reaching almost to the top cover of the pressure vessel, a cylindrical body is fixed to the upper end of the wall of the central superheating section; a shield, with penetrating steam paths, is inserted into the cylinder. When exchanging fuels, this cylindrical body is removed. (NSA of Japan)

50757 STEAM-COOLED FAST REACTOR: A PILOT STUDY. Hannerz, K. (Allmana Svenska Elektriska A.B., Vasteras, Sweden). Tek. Tidskr., 98: 591-5(1968). (In Swedish).

A pilot study of steam-cooled fast reactors is reviewed. A reactor with 1,080 MW(e) effect (2,950 MW(t)) is described. Its fuel consists of 80% UO_2–20% PuO_2. The fuel charge is 26 metric tons in core and 44 metric tons in the blanket. The core diameter is 3.08 m and the height is 0.725 m. The temp. at the outer surface of the cladding is 750°C and the steam temp. 520°C. Comparisons are made with Na-cooled fast reactors. It is pointed out that the competition power of the steam-cooled reactor heavily depends on the price of U. (Swed.)

50758 THE TURBINE FOR THE OSKARSHAMN NUCLEAR POWER PLANT. Norberg, Lars (Stal-Laval Turbin AB, Finspang, Sweden). Tek. Tidskr., 98: 575-7(1968). (In Swedish).

The turbine for the Oskarshamn nuclear power plant is briefly described. It consists of a high-pressure section, a steam-heated intermediate superheater, a low-pressure section, a condenser, a preheater and pumps. It is the largest one so far manufactured in Sweden. Its effect is 460 MW(e). The major data for the steam at inlet are: pressure, 68 bars; temperature, 284°C; humidity, less or equal to 0.5%; and flux, 639 kg/sec. (Swed.)

50759 SAFETY DEVICE FOR A NUCLEAR-SUPERHEATING REACTOR. Sugino, Shigemi (to Hitachi Ltd.). Japanese Patent 1968-7273. Apr. 1, 1968. Filed Dec. 3, 1965.

In the superheating nuclear reactor, steam, produced in the outer boiling region, enters the central superheating region from above and leaves the reactor from the bottom. Means to detect the rupture of a superheating steam line especially outside the reactor pressure vessel are provided. By this detection the central-region cooling water-supply system is operated to inject water into the central region both by the spray above this region and from the superheated steam paths below the region. (NSA of Japan)

50760 DETERMINATION OF EFFECTS OF CROSS SECTION ERRORS ON FAST REACTOR CALCULATIONS. Celentano, Romano; Gandini, Augusto (CNEN, Rome). pp 71-85 of Fisica del Reattore. Rome, Consiglio Nazionale delle Ricerche, 1966. (In Italian).

From Conference on Physics of Reactors, Milan. See CONF-469.

Fuel volume fractions for six reference fast reactor cores are tabulated; core volumes range from 400–2500 l. Sensitivity of reactivity to change in cross section is evaluated; results are tabulated for each core volume. Effects of cross section variation on initial conversion factors is discussed. (M.L.S.)

50761 DETERMINATION OF THE REACTIVITY AND OF THE FLUX DISTRIBUTION IN ALL THE LATINA REACTOR: COMPARISON WITH THE EXPERIMENTAL RESULT OF THE START-UP. Ciancio, G. (CNEN, Rome); Del Buono, A.; Negrini, R.; Paoletti Gualandi, M.; Passarini, C.; Marzullo, T.; Zaffiro, B. pp 99-129 of Fisica del Reattore. Rome, Consiglio Nazionale delle Ricerche, 1966. (In Italian).

From Conference on Physics of Reactors, Milan. See CONF-469.

Initial flux and reactivity measurements in the Latina Power Reactor core are described; measured values are shown as a function of radial distance from core centerline. Calculational techniques used for preexperimental predictions are described; comparisons of measured and calculated values are made. Neutron leakage from the active core zone is calculated; results are shown graphically. (M.L.S.)

50762 LIFETIME OF GAS-COOLED GRAPHITE-MODERATED NATURAL OR ENRICHED URANIUM CORES. Zamparo, Giuseppe (Univ., Genoa. ACF Industries, Inc., Washington, D. C.). pp 159-80 of Fisica del Reattore. Rome, Consiglio Nazionale delle Ricerche, 1966. (In Italian).

From Conference on Physics of Reactors, Milan. See CONF-469.

Expressions for gas-cooled graphite moderated reactor core lifetime are developed for natural U fueled reactors. The formation of Pu is considered; the variation of flux with time is shown graphically. X, Sm, and fission product buildup is discussed. Equations describing the use of enriched fuels are, then, developed; initial conversion ratios are discussed. Effective multiplication factors for a cold clean core are tabulated. (M.L.S.)

50763 "HARBOR": CODE FOR A ONE DIMENSION, TWO GROUP CALCULATION OF THE FLUX AND K_{eff} IN A BOILING WATER REACTOR. Buffoni, Giuseppe; Faetti, Anna; Pepino, Angelantonio (CNEN, Rome). pp 233-44 of Fisica del Reattore. Rome, Consiglio Nazionale delle Ricerche, 1966. (In Italian).

From Conference on Physics of Reactors, Milan. See CONF-469.

The theoretical basis for the computer program Harbor is given. The program is for calculation of neutron flux and effective multiplication factors for boiling water reactors. The method for calculation of void fraction is outlined; methods for determination of reactor parameters are described; the process for flux and reactivity calculations from a Fourier series expansion is outlined (M.L.S.)

50764 PROGRAM PEARL: ANALYSIS OF THE THERMAL REACTOR LIFETIME BY A PERTURBATION METHOD. Cardosi, Gianfranco; Loizzo, Paolo; Ricci, Antonio; Tondinelli, Luciano (CNEN, Rome). pp 245-60 of Fisica del Reattore. Rome, Consiglio Nazionale delle Ricerche, 1966. (In Italian).

From Conference on Physics of Reactors, Milan. See CONF-469.

A description of the program PEARL is given. This is a pro-

gram for simulation of burnup in a two-dimensional thermal reactor. The thermal-hydraulic, neutronic, and physical models, on which the program is based, are outlined. Structuring of the program is described. (M.L.S.)

50765 PROBLEMS WITH FLUX FLATTENING IN A GAS-GRAPHITE POWER REACTOR. Marzullo, Tommaso; Zaffiro, Baldassarre (ENEL, Rome). pp 439-53 of Fisica del Reattore. Rome, Consiglio Nazionale delle Ricerche, 1966. (In Italian).

From Conference on Physics of Reactors, Milan. See CONF-469.

Problems associated with flux flattening in gas-cooled graphite-moderated reactors are discussed; effects of the flux flattening are considered. Effects of flux flattening on cost of produced electricty per kWh are shown graphically. The methods used for flux flattening are described. Application of these techniques to power reactors is summarized. (M.L.S.)

50766 LARGE POWER STATION UNITS: ARGUMENTS FOR AND AGAINST THEIR INTRODUCTION. Eitz, A. W. (Gesellschaft fuer Kernforschung, Karlsruhe, Ger.); Theilsiefje, K. Atomwirt., Atomtech., 13: 410-15(Aug.-Sept. 1968). (In German).

Economic arguments for and against the construction of large power stations are examined. Arguments against large units include: higher specific capital costs; the need for a large reserve capacity; and higher investment in the distribution grid. Arguments for large units include: lower specific fixed costs; the availability of the necessary reserve capacity at low cost; and the location of large units near consumption centers to avoid distribution costs. (H.D.R.)

50767 BOILER ELEMENT FABRICATION FOR THE ADVANCED GAS-COOLED REACTOR AT DUNGENESS "B" NUCLEAR POWER STATION. Gifford, A. M.; Thrower, A. Weld. Metal Fabr., 36: 327-32(Sept. 1968).

Each half of each of the four boilers comprises an economizer, evaporator, and superheater bank operating on the once-through system. The three banks, each of 31 curved elements, were fabricated from integral finned tubes of carbon steel, 9Cr–1Mo steel, and stainless steel, respectively. Details are given of the machining and welding processes used for the return bends and transition joints. Automatic orbital welding equipment was developed for the Tig root welds on the return bends. The heat treatment and testing operations are described. (UK)

50768 OPTIMIZATION OF A NUCLEAR POWER PLANT BY HYBRID COMPUTER. Kovacs, Joseph J. (Electronic Associates, Inc., Princeton, N. J.). Comput. Automat., 17: No. 7, 26-31(July 1968).

A nuclear power plant study performed with a hybrid computer is summarized. The hybrid computer combines the speed of the analog computer with the logical power and flexibility of the digital computer. The physical system is outlined, and the programming techniques that resulted in the computer model of the power plant are described. (H.D.R.)

50769 150-Mgd DUAL-PURPOSE PLANT FOR THE METROPOLITAN WATER DISTRICT OF SOUTHERN CALIFORNIA. Davis, W. Kenneth (Bechtel Corp., San Francisco); Galstaun, Lionel; Scharpf, Carl. Desalination, 2: 227-33(1967).

A feasibility study is presented for the Metropolitan Water District of Southern California, in cooperation with the U. S. Office of Saline Water and the Atomic Energy Commission, for a dual-purpose power and desalting plant capable of producing up to 150 Mgd of fresh water and a large block of power for Southern California. It was proposed that the power features of the project be expanded to 2 nuclear steam supply systems, each capable of providing steam for generating 750 MW(e) in addition to the capacity to operate a 350-MW back-pressure turbine generator for District use, including furnishing steam for the desalting process. (BBB)

50770 SUBSIDIES FOR HARD COAL: THREAT TO NUCLEAR ENERGY. Edler, E.; Schlitt, A. (Deutsches Atomforum eV, Bonn). Atomwirt., Atomtech., 13: 404-7(Aug.-Sept. 1968). (In German).

Subsidies to support the hard coal mines in the German Federal Republic are examined from the standpoint of their effects on the construction of new power stations. Measures to lower coal costs have led to intensive construction of coal-fired stations and have hindered the construction of nuclear power stations. Plans to extend the subsidies beyond 1971 raise fears that nuclear energy development would be seriously threatened. (H.D.R.)

50771 CONTROLLER OPTIMIZATION FOR PRESSURIZED WATER REACTOR. Batenburg, Abram. Pittsburgh, Univ. of Pittsburgh, 1967. 196p.

Thesis.

A specific approach for extending the state-of-the-art of optimal controller design for pressurized water reactors is described. A major accomplishment is the recognition that controller optimization can be formulated in terms of the design of the process. The objective is to restrict the steady-state full-power operating point of the pressurized water reactor as little as possible due to margins that must be included to account for controlled transients. This can be expressed as the requirement to limit the peak attained by a linear combination of state variables during such a transient. After this transient peak (or combination of peaks) has been controlled satisfactorily, it then becomes necessary to return the reactor to the desired steady-state conditions. In order to achieve meaningful analysis for a process of the size of a pressurized water reactor, it is advantageous to proceed in steps. First the plant is linearized; this facilitates an analytical solution of the control problem. This results in the optimal control signals on an open-loop basis. The next step is to determine a feedback controller to generate the previously calculated optimal control. The final step is the optimization of the parameters of the feedback controllers for the nonlinear plant. The first and third step are successfully completed. Step two is not implemented and further study is indicated. An unsought for, but very attractive, feature of the control of the transient peaks is that the optimal control is also minimum time control if the transients are as adverse as expected. (Disser. Abstr.)

50772 NUCLEAR REACTORS. Barker, Allen (to English Electric Co., Ltd.). British Patent 1,128,913. Oct. 2, 1968. Filed Feb. 5, 1965.

A description of a liquid metal-cooled nuclear reactor is presented. The reactor consists of tank-enclosed core with multiple external heat exchangers. A pump forms a closed circuit coolant loop. The heat exchangers consist of groups of multiple rectangular plates. The end plates of the rectangular plates are hollow so that secondary coolant enters for heat transfer. The outlet for the secondary coolant is located at the other end of the pairs of plates. (D.C.C.)

50773 IMPROVEMENTS IN GRAPHITE BRICK STRUCTURES. Triggs, Geoffrey William (to United Kingdom Atomic Energy Authority). British Patent 1,129,265. Oct. 2, 1968. Filed Dec. 4, 1964.

A description of a nuclear reactor graphite brick moderator structure is presented. The structure consists of juxtaposed columns of graphite bricks connected with co-operating projections and recesses on adjacent faces of the bricks. The projections are formed from separate components inserted into the bricks. The pair of straight edges of each projection are normal to the plane including the center of the moderator and vertical axis of the column. The bricks have end projections of accurate contour with a central portion forming a pair of parallel straight edges. (D.C.C.)

50774 IMPROVEMENTS RELATING TO IMMERSION HEATERS FOR NUCLEAR REACTOR PRESSURIZERS. Holt, Frank; Prince, Michael John (to United Kingdom Atomic Energy Authority). British Patent 1,128,819. Oct. 2, 1968. Filed Oct. 6, 1965.

An immersion heater for a pressurized-water nuclear reactor is described. The heater consists of a star-connected three-phase transformer and neutral conductor with multiple metal-sheathed wire elements. The wire elements are straight and insulator-filled. (D.C.C.)

50775 FUEL ASSEMBLY FOR A NUCLEAR REACTOR COOLED BY A LIQUID METAL. Gumuchian, Andre; Migadel, Marcel; Sauvage, Michel (to Commissariat a l'Energie Atomique). British Patent 1,128,826. Oct. 2, 1968. Priority date July 22, 1965, France.

A description of a fuel assembly for a liquid metal-cooled fast reactor is presented. The reactor is enclosed in a pressure vessel and has upward coolant flow. The liquid metal-coolant enters the bottom of the vessel and exits through lateral discharge conduits. The core consists of multiple vertical and parallel elongated fuel elements with a lower fuel region, an intermediate region of neutron-absorbent material, and an upper region of neutron-absorbent material. (D.C.C.)

50776 NUCLEAR REACTORS. Wallhead, Leonard Edward (to English Electric Co., Ltd.). British Patent 1,129,363. Oct. 2, 1968. Filed July 8, 1965.

A description of a gas-cooled nuclear reactor is presented. The reactor includes a pressure vessel, a graphite-moderated core with longitudinal fuel channels, a transverse-connected coolant-gas outlet plenum located at the end of the fuel channels, and a graphite neutron shield which also serves as a core support. The neutron shield is supported by the steel liner of the pressure vessel. Cooling water is circulated through the support structure. (D.C.C.)

Marine and Portable Power Reactors

50777 (GMAD-3078-20(Vol.1)) MCR SYSTEM PARAMETRIC STUDIES. BASIC CONCEPT. Lochbaum, R.; Covert, R.; Baysden, J.; Hyatt, M. (General Motors Corp., Indianapolis, Ind. Allison Div.). May 3, 1965. Contract AT(30-1)-3078. 190p. (EDR-4186(Vol.1)). Dep. CFSTI.

A comprehensive parametric analysis of MCR-type mobile nuclear powerplants in the range of 1.5 to 15 MW(e) is presented. The independent parameters selected to define the basic concept system are reactor outlet temperature, liquid metal temperature rise in the reactor, maximum coolant velocity in the reactor, reactor vessel diameter, number of heat exchanger tubes per pass per transverse pitch, engine compression ratio, and turbine inlet temperature. The values of the independent parameters which produce maximum net electrical output with respect to plant weight do not change over the range of power output. (auth)

50778 (GMAD-3078-20(Vol.2)) MCR SYSTEM PARAMETRIC STUDIES. PACKAGING PARAMETRIC STUDIES BASIC CONCEPTS. Lochbaum, R.; Covert, R. (General Motors Corp., Indianapolis, Ind. Allison Div.). May 3, 1965. Contract AT(30-1)-3078. 52p. (EDR-4186(Vol.2)). Dep. CFSTI.

A comprehensive parametric analysis of MCR-type mobile nuclear powerplants in the range of 1.5 to 15 MW(e) is presented. Parametric packaging studies show that systems with package weight limits of 35,000, 50,000, 65,000, and 100,000 lb are capable of producing 4.25, 6.7, 9.1, and 14.65 MW(e), respectively. (auth)

50779 (GMAD-3078-20(Vol.3)) MCR SYSTEM PARAMETRIC STUDIES. ALTERNATE COMPONENT CONCEPTS. Covert, R.; Baysden, J.; Hyatt, M.; Debord, C. (General Motors Corp., Indiapolis, Ind. Allison Div.). May 3, 1965. Contract AT(30-1)-3078. 222p. (EDR-4186(Vol.3)). Dep. CFSTI.

A comprehensive parametric analysis of MCR-type mobile nuclear powerplants in the range of 1.5 to 15 MW(e) is presented. Studies of systems incorporating alternate component concepts show that three alternates offer increased system performance—increased reactor fuel burnup, adding intercooling and regeneration to the open Brayton cycle, and using He or N_2 in closed and pressurized Brayton cycles with intercooling and regeneration. Also, the use of a borated water shield is attractive from a cost viewpoint. (auth)

50780 (GMAD-3078-20(Vol.4)) MCR SYSTEM PARAMETRIC STUDIES. ALTERNATE COMPONENT SUPPORT STUDIES. (General Motors Corp., Indianapolis, Ind. Allison Div.). May 3, 1965. Contract AT(30-1)-3078. 202p. (EDR-4186(Vol.4)). Dep. CFSTI.

A comprehensive parametric analysis of MCR-type mobile nuclear powerplants in the range of 1.5 to 15 MW(e) is presented. Support studies of other alternate component concepts show that these components offer possibilities for improvement of system performance or cost as follows: minimum ceramic fuel loading of Nb cermets, hollow pin fuel elements, two-zone fuel enrichment loadings, reflector thickness variation, LiH casting, boral in the shield, LiH as the innermost shield layer, shaped shielding, borated plastic shielding, replacement of shield ^{10}B with natural B, self-contained primary loop pressurization, and modular plate primary heat exchangers. (auth)

50781 PRESSURE VESSEL FOR A NUCLEAR-POWERED SHIP. Goto, Jiro (to Hitachi Ltd.). Japanese Patent 1968-8596. Apr. 16, 1968. Filed Oct. 9, 1964.

By the method proposed, when a nuclear-powered ship is inclined and the level of water in the pressure vessel is disturbed, the emergence above the water level of the upright heater rods from the vessel bottom is prevented. The bottom plate of the cylindrical pressure vessel is convex into the interior of the vessel. Upright heater rods are fixed in the bottom plate in such a way that the tops of the rods become lower from the center towards the vessel wall; an upright surge-chamber is set at the center of the convex plate. (NSA of Japan)

Rocket and Space Reactors

50782 (APEX-918) REACTOR AND SHIELD PHYSICS. Comprehensive Technical Report, General Electric Direct-Air-Cycle, Aircraft Nuclear Propulsion Program. Edwards, W. E.; Simpson, J. D. (General Electric Co., Cincinnati, Ohio. Flight Propulsion Lab. Dept.). May 31, 1962. Contracts AF33(600)-38062; AT(11-1)-171. 207p. Dep. CFSTI.

The experimental and theoretical work accomplished in the areas of reactor and shield physics for the ANP Program is described. The reactor physics technology for all ANP reactor types is presented in its most advanced stage; i.e., no attempt is made to present chronologically the development of the technology. The use of automated techniques for power-mapping critical experiments in the reactor physics program are discussed, with particular attention to the use of high speed computer programs employing the IBM 704 and IBM 7090 computing systems. In the nuclear shielding program, efforts are concentrated in two main areas: the optimum placement of shield materials to reduce radiation levels, and the calculation of specific nuclear data, such as nuclear heating and activation, which are important to the design of an efficient, safe power plant. Methods are developed for determining, at any position in the reactor-shield assembly, the total flux and the angle and energy distribution of neutron and gamma rays, as well as the response of any detector used to measure radiation effects. Important shielding computer codes described are the point kernel and single scattering codes and the more recently developed Monte Carlo codes. (auth)

50783 NUCLEAR-POWERED AIRCRAFT AS AN AIRBORNE LABORATORY. Greenwood, Stuart William (Univ. of Manitoba, Winnepeg, Can.). Astronaut. Aeronaut., 6: 40-1 (July 1968).

It is proposed that nuclear-powered aircraft be used for continuous observation of fixed distant points in space and continuous investigation of the atmosphere with the Sun at a fixed position in the sky. For study of upper atmosphere phenomena and for space observation, it is desirable to operate at the highest altitude practicable. For continuous observation of distant objects in space, such as the Sun, or for upper-atmosphere studies in which the position of the Sun in the sky is held fixed, it is necessary to fly along a parallel of latitude in the opposite direction to the rotation of the Earth and at a speed that counters the effect of the Earth's rotation. The flight Mach number at the equator is 1.58 and varies according to a cosine relation to zero at each pole. In this speed range, the most practicable operating conditions are at high subsonic speeds. The condition given by a flight Mach number of 0.79 and a latitude of 60° is taken for illustration. Nuclear-powered aircraft are likely to become practical at gross weights of around 1 million lb. A payload of about 300,000 lb is quoted for an aircraft flying at Mach 0.7 to 0.8 at 36,000 ft. This offers considerable scope for airborne experiments. The Lockheed C-5A Galaxy and the Boeing 747 in their developed versions may well constitute suitable opportunities for adaptation to nuclear power. The flight paths outlined offer the prospect of purposive utilization during what may prove to be lengthy development periods. (BBB)

50784 A NUCLEAR SPACE PLANE PROPULSION SYSTEM USING GASEOUS AND LIQUEFIED PLANETARY ATMOSPHERES AS A PROPELLANT FOR EXTENDED FLIGHT AND MANEUVERING CAPABILITY. Smith, Steven P. D. Gainesville, Fla., Univ. of Florida, 1967. 212p.

Thesis.

A new advanced nuclear propulsion concept and its capabilities in meeting the need for maneuverable vehicles that can operate in both the atmospheric and space regions is explored. A large degree of versatility can be achieved by utilizing the atmosphere in both the gaseous and liquefied state as a propellant in a vehicle equipped with nuclear power. A nuclear core will function as a heat exchanger in both a nuclear turbojet or ramjet scheme or when the system is operating in a rocket mode. While the vehicle is operating in the turbojet or ramjet mode, additional atmospheric fluid can be ingested and liquefied by any of several possible thermodynamic cycles. Used as a rocket propellant, this stored liquefied atmospheric fluid can provide a flight system with atmospheric hypersonic dash or orbital maneuvering capability. The theoretical analysis and preliminary designs of hybrid vehicles which have nuclear engines and airborne propellant acquisition systems are presented. Such a flight system would have the capability of descending from a planetary orbit into the atmosphere, liquefying some of the constituents of that atmosphere, landing on the surface, taking off and again liquefying some of the atmosphere, and then proceeding back into orbit and maneuvering again from the orbit. Since this sequence can be repeated again and again, this flight system has superior maneuvering capabilities over conventional nuclear and chemical systems. A flight system could function as an aerospace research probe; as a cargo or fuel tanker or a personnel carrier for space stations; as a planetary reconnaissance vehicle; and as an air defense vehicle. The effect of the variations in the atmospheric composition and conditions for the possible nuclear engines are shown. The nuclear study was carried out using P_1 and neutron thermalization codes to obtain cross-sectional data, and by using a multigroup diffusion theory code for the criticality calculations. (Disser. Abstr.)

50785 REACTOR FUEL ELEMENT FOR A NUCLEAR ROCKET MOTOR. Rom, F. E. (to United States Atomic Energy Commission). U. S. Patent 3,378,455. Apr. 16, 1968.

A reactor fuel element is described for rocket propulsion. The fuel elements are multiple W-clad $^{184}W-UO_2$ plates mounted in spaced relationship with passages for conducting a fluid propellant. (auth)

Process Heat and Desalination Reactors

50786 CHARACTERISTICS OF THE PWR AS AN ENERGY SOURCE IN A POWER-DESALTING APPLICATION. O'Toole, J. D.; Comtois, W. H.; Stinson, W. H. (Westinghouse Electric Corp., Pittsburgh). Chem. Age India, 18: 187-91(Mar. 1967).

A typical combination nuclear power and water desalting plant is described, and some of the economic characteristics of plants employing pressurized water reactors are presented. (H.D.R.)

Research and Test Reactors and Critical Assemblies

Refer also to abstracts 48977, 48982, 49807, and 50699.

50787 (AAEC/TM-461) THEORETICAL ANALYSIS OF SOME HEAVY WATER NATURAL URANIUM LATTICES. Doherty, G. (Australian Atomic Energy Commission Research Establishment, Lucas Heights). July 1968. 17p. Dep.

A survey is presented of 63 single rod natural U, heavy water lattices to assess the reliability of the GYMEA-WDSN calculation scheme for such systems. With the present group structure and nuclear data the predictions of k_{eff} for these lattices are about 1% low over a range of rod sizes and spacings. (auth)

50788 (AE-330) STUDIES OF THE EFFECT OF HEAVY WATER IN THE FAST REACTOR FRO. Tiren, L. I.; Haekansson, R.; Karmhag, B. (Aktiebolaget Atomenergi, Stockholm (Sweden)). Aug. 1968. 25p. Dep.

Core 9 of the FRO fast critical assembly was diluted with heavy water to 24 vol. per cent, contained in thinwalled Cu cans. Measurements of the critical mass and the reactivity coefficient of heavy water in this core are presented. The effect of the heterogeneous core composition on these items is also discussed. The results are compared with theoretical predictions using several computer codes. Criticality is accurately predicted, but the measured reactivity coefficient of heavy water is about 20% lower than the value obtained with the best available methods, involving the SPENG and DTF-4 programmes. The result of bunching measurements, in which the degree of heterogeneity of core composition was changed, is compared with theoretical estimates of the resonance shielding, flux advantage and leakage components of the heterogeneity effect. (auth)

50789 (AECL-3070(Pt.1)) U-3 ORGANIC LOOP OPERATION AND COOLANT CHEMISTRY. PART 1. MARCH 1963-DECEMBER 1965. Smee, J. L. (Atomic Energy of Canada Ltd., Pinawa (Manitoba). Whiteshell Nuclear Research Establishment). May 1968. 61p. Dep. CFSTI. CAN $1.50.

The U-3 coolant chemistry is described from the start of loop operation in 1963 to the end of 1965. Three fuel irradiations, U-301, U-302 and U-305, took place during this period and these are discussed. The commissioning period lasted 14 months because of two main problems: (i) Leakage through pump seals. This was overcome by installation of a cool seal flushing flow. (ii) Contamination of the loop with an organic impurity which plated out on cold surfaces and plugged filters. It seems likely that this impurity was present in the high molecular weight residues which formed 30% of the initial coolant charge. It was removed by continuous purification with Attapulgus clay and filters. Because of high coolant fouling potential during the first two fuel tests, a series of fouling experiments was done in 1964-1965 to examine some variables which might contribute to fouling. These tests showed that: (i) If the water content of the coolant dropped below 100 μg H_2O/g, the fouling potential increased. (ii) Contact of the coolant with air increased the fouling potential. (iii) Radiation, particularly fast neutrons, increased the fouling potential considerably. (auth)

50790 (AERE-M-2072) IMPROVEMENTS TO LIQUID-NITROGEN LINES OF THE DIDO LIQUID-NITROGEN LOOP (JOB No. 90593). Fontaine, V. L. (ed.) (Atomic Energy Research Establishment, Harwell (England)). May 1968. 16p. Dep. CFSTI. UK 3s. 0d.

Investigations are outlined of the reasons for low thermal insulation on the flexible liquid N_2 lines of the DIDO Liquid Nitrogen Irradiation Loop. Possible remedies are described, and the procedure for and results of the chosen remedy are reported. (auth)

50791 (ANL-7373) DETERMINATION OF GAMMA-RAY HEATING IN A CRITICAL FACILITY BY THERMOLUMINESCENT DOSIMETRY. Stanford, George S.; Johnson, Ted W. (Argonne National Lab., Ill.). Feb. 1968. Contract W-31-109-eng-38. 45p. Dep. CFSTI.

Because of good sensitivity, small probe size, and relative ease of handling, thermoluminescent dosimetry (TLD) provides a useful method for measuring gamma-ray heating in critical facilities. The Bragg-Gray principle of cavity ionization is useful in analyzing the data if thin layers of phosphor, surrounded only by the material in which heating is to be measured, are used. Measurements made during critical experiments for the Argonne Advanced Research Reactor are reported. The phosphor used was CaF_2: Mn. Investigation of sensitivity to thermal and fast neutrons failed to reveal any appreciable perturbations under the experimental conditions encountered. Reproducibility of relative measurements was about 5 to 10%, which was adequate for the purpose; refinements in technique could improve on that. For absolute measurements, there were additional uncertainties: ±15% in the measurement of the absolute power of the critical facility and approximately ±10% in a spectrum correction factor. 22 references. (auth)

50792 (BNWL-500(Vol.81)) CONCEPTUAL SYSTEM DESIGN DESCRIPTION FOR THE SODIUM RECEIVING AND PROCESSING SYSTEM. VOLUME 81. Higby, C. W.; Baumgartel, Robert G. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). July 9, 1968. Contract AT(45-1)-1830. 108p. Dep. CFSTI.

Detailed design of the FFTF sodium receiving and processing system is given; engineering drawings are included. Design requirements are listed; hazards associated with the handling of sodium are given. 39 references. (M.L.S.)

50793 (BNWL-511) FABRICATION, CONSTRUCTION, AND INSTALLATION QUALITY ASSURANCE REQUIREMENTS FOR THE FFTF. Meuser, M. H.; Perry, J. A. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Mar. 15, 1968. Contract AT(45-1)-1830. 56p. Dep. CFSTI.

The general requirements for quality assurance for Pacific Northwest Laboratory contractors involved in procurement, fabrication, construction, installation, and testing effort for the FFTF are described. (auth)

50794 (BNWL-623) CONSIDERATIONS ON THE USE OF FUEL MOTION RESTRICTORS IN THE FTR FUEL PINS. Waltar, A. E.; Hagan, J. W.; Hanson, J. E.; Pember, L. A. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Nov. 1967. Contract AT(45-1)-1830. 54p. Dep. CFSTI.

The considerations leading to a decision of whether to incorporate fuel motion restrictors in the reference core FTR fuel pins are analyzed. Types of restrictors are described and analyzed for performance. (auth)

50795 (BNWL-645) STATUS AND EVALUATION OF MIXED OXIDE FUEL. Bailey, W. J. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Apr. 1968. Contract AT(45-1)-1830. 89p. Dep. CFSTI.

A survey of the literature was conducted to aid the current conceptual design work on the PuO_2-UO_2 fuel elements for the Fast Flux Test Facility. The survey discusses information on design, fabrication, and testing of fast reactor mixed oxide fuel elements and associated components. 74 references are included. (auth)

50796 (BNWL-744) NOBLE GAS RELEASE TO FTR COVER GAS. Bunch, W. L. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Mar. 15, 1968. Contract AT(45-1)-1830. 14p. Dep. CFSTI.

Effects of noble gas release from failed fuel elements to FTR cover gas are analyzed. Decay constants and half lives are tabulated for xenon and krypton isotopes. The calculational model for determining noble gas fission product inventory is described. Effects of use of vented fuel and of cladding failure are tabulated. (M.L.S.)

50797 (BNWL-761) NUCLEAR PROOF TEST FACILITY LOCATION STUDY. Higby, C. W.; Meyers, D. J.; Rybarski, E. R.; Shadel, F. H. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Apr. 1968. Contract AT(45-1)-1830. 9p. Dep. CFSTI.

Five potential NPTF locations are evaluated. Estimates of construction and fuel handling costs and construction schedules are presented. (auth)

50798 (BNWL-766) NPTR HEAT TRANSFER ANALYSIS. Baird, Q. L.; Ripfel, H. C. F. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Apr. 18, 1968. Contract AT(45-1)-1830. 14p. Dep. CFSTI.

A heat transfer analysis of the NPTR includes: a consideration of the nuclear and fission heat production; a physical description of the reference and alternate core features; a heat balance determinition for the reference core including loss of air coolant considerations; a heat balance determination for the molten sodium alternate; and heating and cooling considerations for the fuel storage and handling area. Cost and operational aspects of the molten sodium alternate feature are briefly discussed. (auth)

50799 (BNWL–779) TECHNICAL BASES FOR FFTF OPEN TEST POSITION AND CLOSED-LOOP INSTRUMENTATION. Regimbal, J. J. (comp.) (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Apr. 1968. Contract AT(45-1)-1830. 75p. Dep. CFSTI.

The overall objections of the FFTF open test position and closed loop instrumentation are discussed. Instrumentation requirements are tabulated for open and closed loop test positions; reactor safety aspects are emphasized; safety criteria are given. Experiment instrumentation requirements and operation conditions are listed. Analysis of the operation and effectiveness of the instrumentation is detailed. Present instrument technology is assessed; planned development programs are described. 30 references. (M.L.S.)

50800 (BNWL-792) PCTR MEASUREMENT OF k_∞ FOR URANIUM THORIA SUPERCELL. Vaughn, A. D.; Fleischman, R. M. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). July 31, 1968. Contract AT(45-1)-1830. 58p. Dep. CFSTI.

Experimental measurements were made on a test lattice of separable tubes of fuel and target material in a graphite-moderated lattice in the PCTR. Measurements were made of the infinite medium neutron multiplication factor on a defined supercell of three uranium fuel cells and one ThO_2 target cell. The measured parameters include data for two distinct fuel types in lattices with and without coolant consisting of 1.25 wt % enriched uranium fuel and ThO_2 target at 77% theoretical density in separate process tubes. Determinations of k_∞ were made with the coolant channels wet and dry and with two differing fuel sizes to obtain an estimate of the change in reactivity due to water loss as a function of coolant and fuel geometry. (auth)

50801 (BNWL–808) RADIOACTIVE MASS TRANSPORT IN FFTF PRIMARY PIPING. Brehm, W. F. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Aug. 1968. Contract AT(45-1)-1830. 29p. Dep. CFSTI.

Factors affecting mass transport of stainless steel fuel cladding by flowing Na are reviewed. Results of calculation of fission product buildup in FFTF heat transfer piping, using available quantitative mass transfer data, are tabulated; effects of reactor operating conditions are determined. 16 references. (M.L.S.)

50802 (BNWL–818) METHODS OF MEASURING MECHANICAL DISPLACEMENT AND VIBRATION WITH EMPHASIS ON FFTF PRIMARY PIPING AND VESSEL. Brown, R. L. Jr. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Aug. 1968. Contract AT(45-1)-1830. 53p. Dep. CFSTI.

A survey of instrumentation for the measurement of mechanical and vibrational displacements in FFTF primary system components is given. Limits of operation and efficiency are considered relative to FFTF operating conditions. The various types of instruments available for these measurements are discussed; manufacturers and instrument availability are listed. 163 references. (M.L.S.)

50803 (BNWL–826) ELECTRIC GROUNDING STUDY FOR FFTF. Bucholz, C. S. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Aug. 1968. Contract AT(45-1)-1830. 36p. Dep. CFSTI.

A general description of the FFTF site is given. The area grounding system is detailed. The external electric power supply is described; earth resistivity and factors affecting the area grounding are discussed. Grounding systems are described for: the containment sphere, stainless steel piping and vessels, and instrumentation. 19 references. (M.L.S.)

50804 (BNWL–841) EXPERIMENT DESCRIPTION AND HAZARDS EVALUATION FOR THE PACIFIC NORTHWEST LABORATORY MIXED OXIDE (UO_2–PuO_2) CAPSULES FOR INSERTION IN SUBASSEMBLY X011. Pember, L. A. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Aug. 1968. Contract AT(45-1)-1830. 53p. Dep. CFSTI.

A description of pre-irradiated mixed oxide fuel capsule for insertion into EBR-II is given; design parameters and isotopic analyses are tabulated. Fuel pin assembly design drawings are included. Fabrication and testing of the capsule is described. Performance predictions are given; calculated values are shown graphically. 20 references. (M.L.S.)

50805 (IN–1136) ATR STARTUP, ZERO-POWER EXPERIMENTS, AND COMPARISON WITH ATR CRITICAL FACILITY. Henscheid, J. W.; Kaufman, N. C.; Durney, J. L.; Willis, J. B. (Idaho Nuclear Corp., Idaho Falls). Dec. 1967. Contract AT(10-1)-1230. 86p. Dep. CFSTI.

The first critical fuel loading in the ATR was attained July 2, 1967, using the same fuel elements and the same stepwise loading sequence used previously in the ATR Critical Facility (ATRC). The subsequent zero-power test program, which had also been performed previously in the ATRC, demonstrated adequate nuclear correspondence between the two reactors. The positions of the outer shims for criticality with the full fuel loading of 39 kg ^{235}U indicated that the excess reactivity in the ATR is only 0.3 dollars less than it is in the same fuel loading in the ATRC. Subsequent shim calibration experiments indicate that this apparent difference in excess reactivity is due to slight physical differences between the outer shim hafnium plates in the two reactors. In general, the reactivity worths of the ATR outer shims and neck shims are about 4% more than their ATRC counterparts, although the regulating rod worths are essentially the same in both reactors. The ATR Hf safety rods are worth about 25% more than the ATRC cadmium rods, as predicted from prior measurements in the ATRC. The kinetic parameters β/Λ, measured in two different shim configurations, is the same in both reactors. The void coefficients of reactivity in several typical fuel element coolant channels were also found to be nearly the same in the two reactors. Comparisons of ATR and ATRC power distributions were generally quite good. Lobe powers agree within 1.5%. Fuel element powers differ about 2% on the average. Thermal neutron flux and fission-rate values in typical experiment positions inside the fuel annulus are generally about 5% lower in the ATR than in the ATRC. (auth)

50806 (ORNL-RSIC–23) A SURVEY OF RECENT SOVIET RADIATION SHIELDING WORK. Lewin, J.; Gurney, J.; Trubey, D. K. (Oak Ridge National Lab., Tenn.). Sept. 1968. Contract W-7405-eng-26. 357p. Dep. CFSTI.

A literature survey of Soviet nuclear radiation shielding work, with emphasis on reactor shielding, is presented along with indexed compilations of authors, publications, and abstracts of these publications. The publication period covered is the interval from the Third Geneva Conference, 1964, to the end of the year 1967. Lists of selected periodicals and publications, translated extracts from several significant publications, and a resume of shielding research facilities and equipment are also presented. (auth)

50807 (RFP–1197) EMPIRICAL METHOD FOR CALCULATING PIPE INTERSECTIONS CONTAINING FISSILE SOLUTIONS. Ernst, Bruce B.; Schuske, C. L. (Dow Chemical Co., Golden, Colo. Rocky Flats Div.). Sept. 9, 1968. Contract AT(29-1)-1106. 16p. Dep. CFSTI.

An empirical method has been developed for calculating safe nuclear criticality parameters for complex arrays of intersecting cylinders (pipes or arms) containing enriched uranyl-nitrate solutions. The critical parameters defined by this method include cylinder diameters, angles of intersection, cylinder spacings, and the total number of intersecting cylinders involved in arrays. Discussed also are applications to typical problems encountered in fissile processing plants. (auth)

50808 (RFP–1206) CRITICALITY PARAMETERS AFFECTING EQUIPMENT DESIGN FOR FLUORIDE VOLATILITY PROCESS. Ferguson, Donald R.; Schuske, C. Lee (Dow Chemical Co., Golden, Colo. Rocky Flats Div.). Aug. 29, 1968. Contract AT(29-1)-1106. 6p. Dep. CFSTI.

Various criticality parameters which may have an important influence on the design of fluoride volatility processing equipment are discussed. The data presented may not have direct application to the design of a specific piece of process equipment. However by optimizing the various parameters discussed, in light of process requirements, the designer may provide a basis for a specific model. (auth)

50809 (TID–24646) REACTIVITY WORTH OF WATER HEIGHT IN NORA H_2O CORE NO. 1. Gyimesi, Z.; Haugset, K.; Oei, T. D. (Institutt for Atomenergi, Kjeller (Norway)). Nov. 1966. 40p. Dep. CFSTI.

Pulsed source measurement of water height reactivity worth is performed in NORA H_2O core No. 1. Fundamental mode decay constants and reactivities based on Gozani and Simmons-King technique are evaluated and spatial correction of the measured Gozani data is performed. (auth)

50810 (TID–24696) TRIP REPORT. VISIT TO CEN CADARACHE, FRANCE, AUGUST 6-7, 1968. Hannum, William H. (Atomic Energy Establishment, Winfrith (England)). Aug. 21, 1968. 18p. Dep. CFSTI.

The French program for development and construction of the PHENIX prototype fast reactor is discussed. The fuels irradiation

program in RAPSODIE is described; performance of the facility, as a fuels irradiation facility, is evaluated. The fuel element substitution experiments in MASURCA are described; the PHENIX criticality studies, to be done in MASURCA, are described. The criticality studies being performed in associated critical assemblies are summarized. (M.L.S.)

50811 (TID-24698) MALFUNCTION OF EQUIPMENT INVOLVING SHUTDOWN RODS IN THE PROCESS DEVELOPMENT PILE (PDP). (Division of Operational Safety (AEC), Washington, D. C.). Aug. 5, 1966. 2p. Dep. CFSTI.

Descriptions of two incidents involving control rod withdrawal malfunctions in the PDP are presented. The circumstances behind each incident, the results, and the corrective actions taken are described. (D.C.C.)

50812 (TID-24706) ISPRA CENTER TRIP REPORT. Stachura, Stanley J. (Atomics International, Canoga Park, Calif.). Sept. 6, 1968. 7p. Dep. CFSTI.

Technical discussions concerning the liquid metal boiling research by Dr. Grass are described. The safety analyses and planned experiments for the SORA project are reviewed. Containment experiments are also described. (D.C.C.)

50813 EXPERIMENTS AND CALCULATIONS ON THE ISPRA-2 REACTOR. De Candia, A.; De Carli, A. L.; De Giorgi, G.; Farinelli, U.; Grifoni, S.; Tamagnini, C. (CNEN, Rome). pp 463-78 of Fisica del Reattore. Rome, Consiglio Nazionale delle Ricerche, 1966.

From Conference on Physics of Reactors, Milan. See CONF-469.

The results of critical experiments in Ispra-2 for different core configurations and compositions are compared with calculations and are found to be in good agreement. (H.D.R.)

50814 THEORETICAL ANALYSIS OF CRITICAL MEASUREMENTS IN A NATURAL URANIUM METAL-HEAVY WATER LATTICE. Bonalumi, Riccardo; Zorzoli, Giovanni Battista (CISE, Milan). pp 479-84 of Fisica del Reattore. Rome, Consiglio Nazionale delle Ricerche, 1966. (In Italian).

From Conference on Physics of Reactors, Milan. See CONF-469.

A summary description of the physical model used for criticality measurements in natural U-heavy water lattices is given. Results of the experiments are discussed; methods of data analysis are described. (M.L.S.)

50815 COMPARISON OF CRITICAL EXPERIMENTS WITH CALCULATIONS FOR ORGANIC LATTICES. Bitelli, G.; Grifoni, S.; Martinelli, R.; Orestano, F. V.; Santandrea, E. (CNEN, Rome). pp 485-92 of Fisica del Reattore. Rome, Consiglio Nazionale delle Ricerche, 1966. (In Italian).

From Conference on Physics of Reactors, Milan. See CONF-469.

The core for ROSPO is described; nominal dimensions are given. Methods for calculating nuclear constants and reactivity for organic moderated lattices are described. Reactivity measurements are summarised; measured and calculated values are compared graphically. (M.L.S.)

50816 MEASURE OF SUBSTITUTION IN ORGANIC LATTICES. Conversano, Raffaele (CNEN, Rome). pp 493-500 of Fisica del Reattore. Rome, Consiglio Nazionale delle Ricerche, 1966. (In Italian).

From Conference on Physics of Reactors, Milan. See CONF-469.

The ROSPO lattice and fuel elements are described; fuel elements used in the substitution measurements in the organic moderated ROSPO lattice are shown. The substitution experiments are described. Effects of fuel plate and fuel element variation on reactivity and neutron multiplication are tabulated. (M.L.S.)

50817 PRELIMINARY RESULTS OF THE OSCILLATION EXPERIMENT WITH THE ISPRA-2 REACTOR. De Carli, Anna Luisa; De Giorgi, Giovanni; Pauli, Giulio (CNEN, Rome). pp 563-73 of Fisica del Reattore. Rome, Consiglio Nazionale delle Ricerche, 1966. (In Italian).

From Conference on Physics of Reactors, Milan. See CONF-469.

A basic description of the Ispra-2 research reactor is given; experimental apparatus for oscillator experiments is described. Flow diagrams show hydraulics and electronics for analysis of oscillator experiments. Average cross section values obtained for gold, silver, and cobalt are tabulated; these are discussed briefly. (M.L.S.)

50818 MINISTRUCTURE IN HEAVY WATER TO MEASURE CELL PARAMETERS. Accinni, Filippo; Parmeggiani, Aldo; Zorzoli, Giovanni Battista (CISE, Milan). pp 533-40 of Fisica del Reattore. Rome, Consiglio Nazionale delle Ricerche, 1966. (In Italian).

From Conference on Physics of Reactors, Milan. See CONF-469.

A description is given of the U metal-heavy water lattices used for determination of cell parameters to be used in heavy water power reactors. Calculated neutron flux distributions are shown as a function of lattice radius. The complete mock-up is described briefly. (M.L.S.)

50819 EFFECT OF THE HYDROGEN BOND ON NUCLEAR PARAMETERS. Boffi, Vinicio C.; Molinari, Vincenzo G.; Scozzafava, Romano (CNEN, Rome). pp 693-702 of Fisica del Reattore. Rome, Consiglio Nazionale delle Ricerche, 1966. (In Italian).

From Conference on Physics of Reactors, Milan. See CONF-469.

An analysis of the effects of the chemical bond of hydrogen is given. The total microscopic cross section is shown for hydrogen-bonded atoms diffused in benzene; the thermal neutron spectra in benzene is presented graphically. Organic moderated homogeneous ^{235}U systems are analysed. The average microscopic total and fission cross section for ^{235}U is shown as a function of temperature. Differential effective multiplication factor and differential extrapolation length are tabulated as a function of temperature. (M.L.S.)

50820 DEVICE FOR TAKING OUT A SAMPLE. Tani, Akira (to Nippon Atomic Industry Group Co., Ltd.). Japanese Patent 1967-22869. Dec. 25, 1967. Filed Mar. 30, 1964.

By the method proposed, a sample-containing capsule can be rapidly taken out of the pneumatic-tube transport container after irradiation in a reactor. The capsule is held in the transport container in such a manner as to readily slide out. After running in a pneumatic tube from a reactor, the transport container hits the end of another tube of a smaller diameter which is connected to the pneumatic tube in a straight line. A capsule slips out of the container by the shock. The capsule alone moves on through the smaller-diameter tube; an exhaust hole is cut through the wall of this tube. (NSA of Japan)

50821 REACTOR FOR IRRADIATION TESTS. Haneda, Mikio (to Nippon Atomic Industry Group Co., Ltd.). Japanese Patent 1967-22868. Dec. 25, 1967. Filed Jan. 31, 1964.

The reactor consists of the following: the bottom-closed cylindrical body containing the reactor core; a removable short cylinder connected onto the top of the cylindrical body; the removable cover plate for the short cylinder; a sample-irradiation loop extending vertically from the position of the short cylinder through the core and the bottom of the cylindrical body; and a pipe connected to the top of the loop which runs out of the cylindrical body. (NSA of Japan)

50822 USE OF THE TRIGA REACTOR FOR RESEARCH. Meloni, Sandro (Univ., Pavia, Italy). pp 773-7 of Fisica del Reattore. Rome, Consiglio Nazionale delle Ricerche, 1966. (In Italian).

From Conference on Physics of Reactors, Milan. See CONF-469.

A brief description of the TRIGA research reactor at the University of Pavia is given. Use of the reactor for activation analysis, nuclear chemistry, and radiobiology is discussed. (M.L.S.)

50823 RABBIT-TUBE DEVICE WITH A CHECK VALVE. Saruyama, Ichiro (to Japan Atomic Energy Research Inst.). Japanese Patent 1967-22872. Dec. 25, 1967. Filed Dec. 2, 1964.

By the method proposed, an irradiated sample can be recovered very easily in the rabbit tube. It consists of the following: the outer tube the bottom end of which is closed; the inner tube which opens at the bottom with a stopper for the sample holder; and the sample holder running in the inner tube both ends of which have holes cut through the end plates. A check valve is installed at the bottom end of the sample holder, covering the cut hole from the outside; it is opened as the liquid flows through the holder to leave the bottom hole, and it is closed as the flow is the reverse. When withdrawing the sample holder with a sample the fluid flows downward through the space between the outer and inner tubes, enters the inner tube through the bottom opening, and then the check valve is closed, thereby applying great hydraulic pressure to the sample holder. (NSA of Japan)

50824 DEVICE FOR PREVENTING A RADIATION LEAKAGE. Wase, Keizo (to Hitachi Ltd.). Japanese Patent 1967-22871. Dec. 25, 1967. Filed Feb. 8, 1963.

The device proposed is used for preventing a radiation leakage between the reactor experimental-hole opening and the plug handler. When handling the experimental-hole plug by the handling machine, a narrow clearance is allowed between the reac-

tor wall where the hole penetrates and the front face of the machine when the wall and machine are in virtual contact, in order to prevent "damaging" shock. The actual shielding required is achieved by means of a shielding ring attached at the front face. A circular bracket is attached along the circumference of the circular shield at the front of the handling machine. Rods, penetrating this bracket, press the shielding ring forward with springs between the ring and bracket. "Strikers" are fixed at the other end of the rods; the strikers actuate the switch which operates the plug-handling machine electric motor. (NSA of Japan)

50825 REACTOR RTS-1 GALILEO OF CAMEN DESCRIPTION AND INITIAL CALIBRATION. Bionda, Eugenio; Calamida, Italo; Villa, Eduardo (CAMEN, Pisa, Italy). pp 309-31 of Fisica del Reattore. Rome, Consiglio Nazionale delle Ricerche, 1966. (In Italian).

From Conference on Physics of Reactors, Milan. See CONF-469.

The research reactor RTS-1 Galileo is described. Brief descriptions are given of: pool, core, control rods and control system, auxiliary equipment, experimental apparatus, gamma cell, and irradiation channels. Initial physics measurements and calibrations are discussed. Reactivity worths of core components are tabulated; results of stability tests are listed. (M.L.S.)

50826 MULTIGROUP CALCULATION OF THE REACTOR ROSPO 11/5. Casali, Franco; Melandri, Anna Maria; Pierantoni, Ferrante (CNEN, Bologna). pp 47-62 of Fisica del Reattore. Rome, Consiglio Nazionale delle Ricerche, 1966. (In Italian).

From Conference on Physics of Reactors, Milan. See CONF-469.

A general description of the ROSPO reactor is given. Fuel element design parameters are tabulated; materials constituents for the fuel and reflector regions are listed. Physics parameter calculations for core and radial reflector are described; results are tabulated. Calculations of k_{eff} are described; results are tabulated for an 18 group determination. (M.L.S.)

50827 β/l^* MEASUREMENT BY NEUTRON FLUX NOISE ANALYSIS. Osnaghi, S. (CISE, Milan); Possa, G.; Rimini, A. Energy. Nucl. (Milan), 15: 578-80(Sept. 1968).

Power spectral density measurements of neutron flux noise of L-54 nuclear reactor of the Politechnic School of Milan are presented. Measurements are performed by special purpose device, originally developed for transfer functions analysis. From these measurements the value of β/l^* is evaluated. (auth)

50828 FIRST RELATIVE RESULTS FOR A PARTICULAR CRITICAL CONFIGURATION OF THE REACTOR RB-2. Benedetti, F.; Brighenti, G.; Camiscioni, B.; Chiodi, P. L.; Giuliani, C.; Lovati, A.; Martinuzzi, L.; Vigliano, E. (Societa Nazionale Metanodotti, Milan). pp 333-40 of Fisica del Reattore. Rome, Consiglio Nazionale delle Ricerche, 1966. (In Italian).

From Conference on Physics of Reactors, Milan. See CONF-469.

Kinetics calculations for the RB-2 research reactor are given; neutron multiplication factor is shown as a function of control rod position. Reactivity is shown as a function of control rod position; neutron flux profiles are given as a function of time. Control rod worths are tabulated. (M.L.S.)

50829 DESIGN OF A FAST REACTOR FOR PREPARATION OF TECHNICAL EXPERIMENTS. Farinelli, U.; Gambardella, G.; Gandini, A.; Mathis, A.; Musso, B.; Palamidessi, A.; Santangelo, M. (CNEN, Rome). pp 373-94 of Fisica del Reattore. Rome, Consiglio Nazionale delle Ricerche, 1966. (In Italian).

From Conference on Physics of Reactors, Milan. See CONF-469.

Design parameters for the TAPIRO reactor are listed; each system is described briefly. Composition of core materials is tabulated; critical mass is shown as a function of reflector thickness. Activation calculations for the reflector are tabulated. Hypothetical accidents are considered; possible results of these are shown graphically as dose as a function of time. (M.L.S.)

50830 IMPROVEMENT OF FAST REACTOR EVALUATION BY INTEGRAL EXPERIMENTS. Cecchini, Gian Paolo; Farinelli, Ugo; Gandini, Augusto; Salvatores, Massimo (CNEN, Rome). pp 395-410 of Fisica del Reattore. Rome, Consiglio Nazionale delle Ricerche, 1966.

From Conference on Physics of Reactors, Milan. See CONF-469.

Data requirements in the evaluation of fast reactor performance are discussed, and the applicability of a single few group cross sections set to a broad range of reactors is analyzed. Integral experiments which can yield the required information are evaluated. Several coupled thermal-fast and multizone fast critical facilities are analyzed with respect to the precision obtainable in the integral experiments. Experiments which might give information on transport cross sections are examined. (H.D.R.)

50831 EXPERIMENTAL REACTOR RB-1. CALIBRATION AND MEASUREMENT OF K FOR A NATURAL URANIUM LATTICE MODERATED BY GRAPHITE. Aiello, P.; Azzoni, P.; Casali, F.; (and others) (CNEN, Bologna). pp 341-60 of Fisica del Reattore. Rome, Consiglio Nazionale delle Ricerche, 1966. (In Italian).

From Conference on Physics of Reactors, Milan. See CONF-469.

Reactivity measurements in RB-1 using the supercritical period method are described; calibration of the control rods and control system is discussed. Neutron flux measurements using activation detectors is described. Measurement of infinite neutron multiplication is summarized; data are tabulated. (M.L.S.)

50832 PRELIMINARY CONSIDERATIONS ON SEVERAL TYPES OF FAST REACTORS OF THE DILUTE RAPTUS TYPE. Azzoni, Piero; Cicognani, Gianfranco; Pierantoni, Ferrante (CNEN, Bologna). pp 411-28 of Fisica del Reattore. Rome, Consiglio Nazionale delle Ricerche, 1966. (In Italian).

From Conference on Physics of Reactors, Milan. See CONF-469.

The basis of the RAPTUS program is described. An analysis of the preliminary neutronics of fast dilute reactors of the ^{233}U-Pu and Th-^{233}U type is given. Core, blanket, and reflector volumes are tabulated; critical masses are calculated for different core volumes. 17 references. (M.L.S.)

50833 MODEL FOR CORRELATION OF INTEGRAL EXPERIMENTS WITH FAST NEUTRON SPECTRA. Farinelli, Ugo (CNEN, Rome). pp 429-37 of Fisica del Reattore. Rome, Consiglio Nazionale delle Ricerche, 1966. (In Italian).

From Conference on Physics of Reactors, Milan. See CONF-469.

A method for correlating integral experiments with neutron spectra is described. The mathematical model is developed; the iterative procedure to be used for interpretation is explained. (M.L.S.)

50834 THE PILE OSCILLATOR OF THE MILAN POLYTECHNIC L-54 REACTOR: ITS APPLICATION TO DETERMINATION OF THE ZERO-POWER TRANSFER FUNCTION BETWEEN REACTIVITY AND NEUTRON FLUX. Grugni, G. (CESNEF, Milan); Possa, G.; Rimini, A.; Terrani, S. Energ. Nucl., 15: 643-6 (Oct. 1968). (In Italian).

The pile oscillator of the L-54 nuclear reactor of the Polytechnic School of Milan is briefly described. Some magnitude and phase measurements of the zero power transfer function between reactivity and neutron flux, in the frequency range 10^{-3} ÷ 15 Hz, are presented. From these measurements the value 123 μsec for l^* was obtained. (auth)

50835 UTILIZATION OF THE UNIVERSITY OF PAVIA LENA RESEARCH REACTOR. Rollier, M. A.; Maxia, V.; Meloni, S. (Univ. of Pavia, Italy). Energ. Nucl. (Milan), 15: 647-53(Oct. 1968).

The LENA Laboratory (Laboratorio Energia Nucleare Applicata) of the Pavia University (Science Faculty) is endowed with a research reactor TRIGA Mark II having a 250 kW steady state power and a 250 MW pulsed power. Research programs performed by means of this facility in low energy physics, in nuclear chemistry, and in activation analysis are reviewed. (auth)

Production Reactors

Refer to abstract 50883.

Reactor Theory, Components, Fuels and Accessories

Refer also to abstracts 48996, 49084, 49140, 49148, 49690, 49694–49696, 49706, 49707, 49711, 49730, 49736, 49780, 49790, 49793–49795, 49798–49802, 49804, 49808, 49814, 49817, 49827, 49844, 49861, 49863, 50510–50514, 50520, 50606, and 50699.

50836 (ANL-7162(Suppl.)) STRESS ANALYSIS OF A REACTOR CORE SUPPORT STRUCTURE CONSISTING OF TWO INTERCONNECTED MULTIREGION PLATES. Marchertas, A. H. (Argonne National Lab., Ill.). Mar. 1968. Contract W-31-109-eng-38. 69p. Dep. CFSTI.

A computer program for the stress analysis of a coupled axisymmetric two-plate core support structure is presented. The computer program consists of a main program titled MAIN and five subroutines titled PLATE, PLATTER, EDGE 1, EDGE 2,

and SHELLOUT. The program is written in FORTRAN for the CDC-3600 computer. (D.C.C.)

50837 (ANL-7455) PTHISTRY: A CODE FOR PREDICTING LONG-TERM PRESSURE-TEMPERATURE HISTORY IN SECONDARY CONTAINMENT OF WATER-COOLED REACTORS FOLLOWING ACCIDENT-INDUCED BLOWDOWN. Kristianson, Bryant N. (Argonne National Lab., Ill.). May 1968. Contract W-31-109-eng-38. 82p. Dep. CFSTI.

Written in FORTRAN 63 for the CDC-3600 computer, the PTHISTRY Code (ANL designation: RE-360X) solves a series of heat balance equations. These equations give a time-dependent description of the pressure and temperatures inside the secondary containment after a postulated-water expulsion blowdown accident of the reactor primary system. Included are the input specifications, a sample problem, and a FORTRAN listing of the code. (auth)

50838 (BNWL-831) 2DB USER'S MANUAL. Little, W. W. Jr.; Hardie, R. W. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). July 1968. Contract AT(45-1)-1830. 123p. Dep. CFSTI.

2DB is a two-dimensional (X-Y, R-Z, R-θ), multigroup diffusion code for use in fast reactor criticality and burnup analysis. The code can be used to: compute k_{eff} and perform criticality searches on buckling, time absorption (α), reactor composition, and reactor dimensions by means of either a flux or an adjoint model; and compute material burnup. All programming is in FORTRAN-IV. Since variable dimensioning is employed, no simple restrictions on problem complexity can be stated. However, in a 65K memory, the current version is nominally restricted to 50 energy groups. Running time (for a k_{eff} calculation) on a UNIVAC 1108 is about 1 minute for a 30 × 30 mesh problem using 4 energy groups. (auth)

50839 (DPST-68-372) XENON OSCILLATION DEPENDENCE ON REACTOR PARAMETERS. Vandervelde, V. D. (Du Pont de Nemours (E. I.) and Co., Aiken, S. C. Savannah River Lab.). May 1968. Contract AT(07-2)-1. 45p. Dep. CFSTI.

A large reactor, operating at high neutron flux levels, is subject to spatial oscillations in the power distribution associated with the cyclical redistribution of ^{135}Xe. Curves as a function of the reactor parameters, not only for sustained oscillations (damping = 1), but for oscillations with damping factors less than 1 (increasing oscillations) and greater than 1 (damped oscillations) are presented. The curves are obtained through a direct extension of the Randall-St. John equations, the derivations of which are presented. Because the equations are linearized through use of the small perturbation approximation, the accuracy decreases as the departure from a steady state increases. An additional extension is the inclusion of the flux shape factor, Λ_j, for the second as well as the first harmonic for symmetrical two-region reactors with "humped" and "dished," as well as flattened flux shapes, for both the axial and radial dimensions. The information is intended to be used as a simple method for determining the status, with respect to Xe oscillation, of reactors that approximate the inherent assumptions in the calculations. It is directly applicable to reactors in which void coefficients do not play a dominant role in determining reactor dynamics. Differences in the type of fuel and/or moderator of a reactor do not invalidate the use of the information as long as the required parameters can be determined with reasonable accuracy. (auth)

50840 (IN-1170) APPLICABILITY OF CHEMICALLY REMOVABLE COATINGS TO REACTOR CONTAINMENT BUILDINGS. Newby, B. J. (Idaho Nuclear Corp., Idaho Falls). Aug. 1968. Contract AT(10-1)-1230. 34p. Dep. CFSTI.

Two methods are described for the rapid remote decontamination of coated interiors of reactor containment buildings contaminated with volatile fission products, namely, the use of chemically strippable or chemically corrodible coatings. Both methods are based on the removal of temporary coatings containing the contamination with chemical reagents. (auth)

50841 (LA-3993) ADVANCED PLUTONIUM FUELS PROGRAM. Quarterly Status Report, April 1-June 30, 1968, and Second Annual Report, FY 1968. (Los Alamos Scientific Lab., N. Mex.). Sept. 12, 1968. Contract W-7405-eng-36. 114p. Dep. CFSTI.

SODIUM—behavior of liquid, effects of impurities on; development technology for liquid, analysis of Los Alamos Scientific Laboratory 1968; bonding compatibility of, compatibility of Type 316 stainless steel-cladding with plutonium carbide (PuC)-uranium carbide (UC) and plutonium nitride PuN)-uranium nitride (UN) using

PLUTONIUM CARBIDES—PuC-UC, fabrication of pellet-shaped, effects of techniques on quality; PuC-UC, thermal properties of analysis at 1600 to 2500°C of; melting behavior of, analysis up to 1660°C of; PuC-UC, compatibility of with Type 316 stainless steel-cladding of sodium bonded, evaluation of; PuC-UC, radiation effects on EBR-2 driver fuel elements, analysis of neutron

CESIUM ISOTOPES (S-137)—impurities of, effects on behavior of liquid sodium of

ORIFICES—plugging meter for liquid sodium systems, operation characteristics of

PLUTONIUM OXIDES PuO_2—PuO_2-UO_2, heat of fusion of, analysis of

URANIUM OXIDES UO_2—PuO_2-UO_2, heat of fusion for, analysis of

PLUTONIUM NITRIDES, URANIUM NITRIDES—PuN-UN, compatibility with Type 316 stainless steel-cladding of sodium bonded, evaluation of

STAINLESS STEEL—cladding of Type 316, compatibility with plutonium carbide (PuC)-uranium carbide (UC) and plutonium nitride (PuN)-uranium nitride (UN) of sodium bonded

EXPERIMENTAL BREEDER REACTOR-II—fission product distribution in fuel pins of, gamma scan analysis of

REACTORS, FAST—physics measurements for breeder, computer programs for calculation of

REACTORS, BREEDER—physics measurements for fast, computer programs for calculation of

REACTOR FUEL ELEMENTS—radiation effects on EBR-2 plutonium carbide (PuC)-uranium carbide (UC), analysis of neutron

NEUTRONS—effects on plutonium carbide (PuC)-uranium carbide (UC) EBR-2 fuel elements, analysis of

URANIUM CARBIDES—PuC-UC, radiation effects on EBR-2 driver fuel elements, analysis of neutron

FAST FLUX TEST FACILITY—fuel development for, evaluation of technology for (D.C.C.)

50842 (ORNL-NSIC-46) A SUMMARY OF NSIC ACTIVITIES, 1963-1967. Buchanan, J. R.; Cottrell, Wm. B. (Oak Ridge National Lab., Tenn.). Sept. 1968. Contract W-7405-eng-26. 39p. Dep. CFSTI.

The Nuclear Safety Information Center serves as a focal point for the collection, analysis, and dissemination of information related to safety problems encountered in the design, analysis, and operation of nuclear facilities. NSIC issues state-of-the-art reports, operates an SDI program, publishes indexed bibliographies, prepares retrospective bibliographies, answers technical inquiries, and offers counsel and guidance on safety problems. Its reference files are stored in a central computer that is accessible by means of a telecommunications station. The services offered by the Center, the manner in which it operates, and the problems encountered in its first 4½ years of operation through December 31, 1967 are described. (auth)

50843 (ORNL-NSIC-51) DESIGN PRINCIPLES OF REACTOR PROTECTION INSTRUMENT SYSTEMS. Hanauer, S. H.; Walker, C. S. (Oak Ridge National Lab., Tenn.). Sept. 1968. Contract W-7405-eng-26. 95p. Dep.

The protection instrument system of a reactor includes those assemblies of instruments, and only those, whose failure to function when needed would be intolerable. Instruments and control devices not part of the protection system constitute the operation system. The protection and operation system should be as nearly independent as possible. Reliability and performance are both required of the protection system. Reliability depends on quality, redundancy and independence of redundant devices, testing, and freedom from failure caused by an accident. Performance can be affected by validity of signals, the manner in which an accident develops, effects on instruments of the accident environment, and other design problems. Protection system design criteria are discussed. Research, development, and testing related to instruments, system performance, and the prediction and measurement of component and system reliability are described. (auth)

50844 (TRG-Report-1547) THEORETICAL ANALYSIS OF SOME FORCES, STRESSES, AND STRAINS PRODUCED IN NUCLEAR FUEL ELEMENT CLADDING BY THERMAL EXPANSION OF CRACKED FUEL PELLETS. Gittus, J. H. (United Kingdom Atomic Energy Authority, Springfields (England). Reactor Group). Aug. 23, 1967. 24p. (JNPC-FEWP-(67)-P.29; SGHWR-FEMWG-P.275; FRPC-FEWP-(67)-P.438). Dep. CFSTI. UK 3s. 6d.

Some of the stress, force and strain distributions produced in collapsed cladding by the expansion of cracked pellets during a power increase have been calculated analytically. As the radial and transverse cracks in the pellet open, the tendency for the cladding to stretch preferentially over them is reduced by frictional sliding at the pellet/clad interface. The frictional forces opposing sliding are intensified by a high coolant pressure (which holds the can onto the fuel) while the ability of the cladding to resist the friction forces without being locally deformed depends on its strength. The coefficient of friction, cladding dimensions,

number of radial pellet cracks, strain hardenability and temperature gradients around the cladding influence the tendency for cladding strain to be concentrated over the opening pellet cracks. (auth)

50845 (Y-DD-23) SOME CONSIDERATIONS IN REGARD TO THE DEVELOPMENT AND USE OF THE KENO PROGRAM. Crume, E. C. Jr. (Union Carbide Corp., Oak Ridge, Tenn. Y-12 Plant). Sept. 20, 1968. Contract W-7405-eng-26. 10p. (CONF-680909-3). Dep. CFSTI.

From Symposium on Neutron Interaction in Arrays of Fissionable Materials, Livermore, Calif.

The Monte Carlo computer program KENO is described. The computer program calculates criticality conditions of bare and reflected individual fissile systems and arrays of systems. The program is designed for three-dimensional systems. (auth)

50846 MEASUREMENT OF DIFFUSION PARAMETERS IN ORGANIC MODERATORS USING A PULSED NEUTRON SOURCE. Demanins, Ferruccio; Rado, Vittorio; Vinci, Francesco (CNEN, Rome). pp 501-8 of Fisica del Reattore. Rome, Consiglio Nazionale delle Ricerche, 1966. (In Italian).

From Conference on Physics of Reactors, Milan. See CONF-469.

Diffusion parameters and age of neutrons at thermal energies were measured at 20°C in benzene, diphenyl, and Dowtherm-A. (H.D.R.)

50847 FISICA DEL REATTORE. CONVEGNO INDETTO DALLA, SOCIETA LOMBARDA DI FISICA, MILANO-PAVIA, DICEMBRE 1963. (Reactor Physics. Meeting of the Lombarda Physics Society, Milan-Pavia, Italy, December 1963). Congressi, Convegni, e Simposi Scientifici. 9. Rome, Consiglio Nazionale delle Ricerche, 1966. 857p. (In English and Italian). (CONF-469).

Included are 66 papers on theoretical and experimental methods for the analysis of nuclear reactor physics. Individual abstracts were prepared for 61 papers. Abstracts of the remaining 5 papers have appeared in previous issues of NSA. The abstract number of one paper is NSA 19: 12796 and the other 4 papers may be located under CONF-469 in the report number indexes. (H.D.R.)

For abstracts of individual papers see: 48885, 49074, 49101, 49102, 49776, 50235, 50239, 50510–50516, 50604–50606, 50752–50754, 50760–50765, 50813–50819, 50822, 50825, 50826, 50828–50833, 50846, 50848–50854, 50861–50866, and 50868–50871.

50848 THEORETICAL ANALYSIS OF SOME PROBLEMS WHICH ARE DUE TO THE PRESENCE OF PLUTONIUM IN HETEROGENEOUS THERMAL REACTORS. Diana, Emilio (EURATOM, Ispra, Italy). pp 541-8 of Fisica del Reattore. Rome, Consiglio Nazionale delle Ricerche, 1966.

From Conference on Physics of Reactors, Milan. See CONF-469.

Reactivity effects due to Pu formation in fuel elements are to be studied in oscillation experiments with Pu-containing fuel elements in the ECO facility. To determine the usefulness of such integral measurements for lattice reactivity calculations, the effect of Pu on the neutron spectrum in the fuel and moderator was investigated. The effects of a nonuniform spatial distribution of Pu in the fuel and the heterogeneous parameters of the fuel are analyzed. (H.D.R.)

50849 APPLICATION OF THE MONTE CARLO METHOD TO THE CALCULATION OF SEVERAL REACTOR PARAMETERS. Cupini, Enrico; de Matteis, Artenio; Richard, Ubaldo (CNEN, Bologna). pp 703-6 of Fisica del Reattore. Rome, Consiglio Nazionale delle Ricerche, 1966. (In Italian).

From Conference on Physics of Reactors, Milan. See CONF-469.

The various computer codes applying Monte Carlo techniques to reactor physics calculations are discussed. Codes are briefly described for calculation of: resonance escape probability from ^{238}U in thermal reactor lattices, resonance parameters for ^{232}Th, and capture probabilities for monoenergetic neutrons in rectangular or hexagonal lattices. (M.L.S.)

50850 CORRELATION BY THE CALCULATION OF PEAK AND DISADVANTAGE FACTORS FOR A SQUARE CLUSTER. Loizzo, Paolo; Manca, Giuseppe (CNEN, Rome). pp 707-20 of Fisica del Reattore. Rome, Consiglio Nazionale delle Ricerche, 1966. (In Italian).

From Conference on Physics of Reactors, Milan. See CONF-469.

The problems associated with calculations of neutron flux peaking in reactor fuel elements and disadvantage factors for the fuel cladding and the moderator are discussed. Disadvantage and peaking factors obtained from the TVT and PDQ codes are tabulated; results are analysed. (M.L.S.)

50851 CONSIDERATIONS ON APPROXIMATE NUMERICAL INTEGRATION OF CERTAIN INTEGRODIFFERENTIAL EQUATIONS WITH DISCONTINUOUS COEFFICIENTS AND RELATED DIFFERENTIAL SYSTEMS. Albertoni, Sergio; Daneri, Adelia; Daneri, Adriana (Univ., Milan. Applicazioni e Ricerche Scientifiche, Milan). pp 721-31 of Fisica del Reattore. Rome, Consiglio Nazionale delle Ricerche, 1966. (In Italian).

From Conference on Physics of Reactors, Milan. See CONF-469.

Methods for solution of integrodifferential equations occurring in mathematical physics are outlined. Discussions on analytical and numerical methods are included. 15 references. (M.L.S.)

50852 LAGUERRE POLYNOMIALS IN THERMAL FLUX CALCULATIONS. Daneri, Adelia; Daneri, Adriana (Applicazioni e Ricerche Scientifiche, Milan). pp 733-40 of Fisica del Reattore. Rome, Consiglio Nazionale delle Ricerche, 1966.

From Conference on Physics of Reactors, Milan. See CONF-469.

A brief survey of the series expansion in Laguerre polynomials of the thermal flux in heavy gaseous moderators is given. The energy operator is studied, and numerical calculations are carried out for an infinite medium to test the convergence rate. (H.D.R.)

50853 DEVELOPMENT AND USE OF SEVERAL METHODS OF APPLIED MATHEMATICS. Biasini, Luciano; Casadei, Giorgio; Richard, Ubaldo (CNEN, Bologna). pp 617-23 of Fisica del Reattore. Rome, Consiglio Nazionale delle Ricerche, 1966. (In Italian).

From Conference on Physics of Reactors, Milan. See CONF-469.

Mathematical methods, applicable to reactor theory calculations, are discussed. Methods for treating partial and ordinary differential equations are described. Numerical integration and asymptotic solution techniques for ordinary differential equations are outlined. Physical situations giving rise to partial differential equations are considered; numerical solution techniques for these equations are discussed briefly. (M.L.S.)

50854 USE OF FIRST COLLISION PROBABILITY IN REACTOR PHYSICS. Bonalumi, Riccardo (CISE, Milan). pp 625-31 of Fisica del Reattore. Rome, Consiglio Nazionale delle Ricerche, 1966. (In Italian).

From Conference on Physics of Reactors, Milan. See CONF-469.

Use of collision formalism in reactor physics is discussed; the fast fission factor, resonance escape probability, thermal utilization factor, thermal fission factor, diffusion coefficient, and calculation of effective collision probability are considered briefly. 27 references. (M.L.S.)

50855 DEVICE FOR MANIPULATING A REACTOR CONTROL ROD. Koreki, Shoji (to Tokyo Shibaura Electric Co., Ltd.). Japanese Patent 1968-3598. Feb. 14, 1968. Filed Feb. 10, 1965.

By the device proposed, when the reactor operator continues to press the push-button for withdrawing a shim control rod, the control rod can stop temporarily at several positions over the length of withdrawal to prevent a reactor runaway. The device consists of the following: two switches for control of the control rod position which are actuated at several positions over the length of withdrawal; the change-over switch for the rod position control switches; a time limit relay which is operated by the state of rod-position control switches; the auxiliary relay which is operated when the withdrawal is suspended and the confirmation made; an indication lamp lighted by the stoppage in operation of the auxiliary relay; an electromagnetic contactor for withdrawal of the control rod which is operated by the switch for rod withdrawal, but suspended by the stoppage in operation of the auxiliary relay or by the operation of an upper-position switch; and, an electromagnetic contactor for insertion of the control rod which is operated by the switch for rod insertion, but suspended by the operation of a lower-position switch. (NSA of Japan)

50856 IRRADIATION CAPSULE. Yoshikawa, Hideo (to Mitsubishi Atomic Power Industry, Inc.). Japanese Patent 1967-22867. Dec. 25, 1967. Filed Jan. 20, 1964.

The irradiation capsule is partitioned into two chambers by a thin plate. In one chamber, the sample is held axially by means of a thin beam. This beam fixed on the end of the capsule runs through the sample and protrudes from it. When the sample is heated, the beam also is heated, and the pointed top of this beam hits the plate, making a hole through the latter. The result is the connection of the two chambers. After irradiation, the existence or non-existence in the second chamber of fission products is observed to obtain the particular temperature at the time of sample irradiation. (NSA of Japan)

50857 CONTROL ELEMENT. Sugaya, Junichi (to Hitachi Ltd.). Japanese Patent 1967-22864. Dec. 25, 1967. Filed Aug. 11, 1965.

An improved control element is proposed which consists of the poison and the fuel portion. When the control sub-element is displaced somewhat due to the cooling water, water can flow uniformly, resulting in the uniform cooling of fuel plates. In the control element rollers with plate springs and fixed rollers are installed on one side, while on the other, fixed rollers alone are installed. (NSA of Japan)

50858 DEVICE FOR DRIVING A CONTROL ROD. Kishida, Koji (to Mitsubishi Electric Corp.). Japanese Patent 1967-22863. Dec. 25, 1967. Filed July 16, 1965.

An improvement in a control-rod driving device of the hydraulic-scram and magnetic-jack type is described. It consists of the following: a long, small-diameter cylindrical body protruding from the reactor pressure vessel which contains the control-rod driving rod; the magnet-coils wound around the cylindrical body which actuate the driving rod; and the piston and its rod which is the driving rod. A small path for the liquid is cut through the piston to keep uniform the pressure above and below the piston; and a spring is also installed connecting the rod and piston. (NSA of Japan)

50859 DEVICE FOR TRANSPORTING A SPENT FUEL. Ito, Yoshiharu (to Hitachi Engineering Co., Ltd.). Japanese Patent 1967-22870. Dec. 25, 1967. Filed Apr. 15, 1964.

The device proposed is used for moving spent fuel elements from the reactor to the storage pond. A transport path connects the fuel exchange water-tank just above the reactor to the spent-fuel storage pond outside the reactor at the level of the reactor bottom. The long transport container, holding a spent fuel element from the reactor, travels through the path in a lying posture. Entering both the fuel exchange water-tank and the spent-fuel storage tank, the transport container is erected with its end as the pivot. (NSA of Japan)

50860 PNEUMATIC TUBE. Yoshiyanagi, Kiyomi (to Hitachi Ltd.). Japanese Patent 1968-7274. Apr. 1, 1968. Filed Apr. 16, 1964.

By the method proposed, the end of a pneumatic tube, where a sample material is held, can change its position within the reactor core freely without affecting the pneumatic-tube performance. Starting at a short distance from the reactor, a section of pneumatic tube extends into the reactor core through the reactor shield; the portion within the reactor is double-walled, the space between the two walls being connected to another pipe just outside the shield. An extension piece of pneumatic tube is connected to the section using an O ring. A means is provided to rotate partly the extension piece so that its end within the core can change its position. (NSA of Japan)

50861 SEVERAL RECENT ASPECTS OF CALCULATION FOR HETEROGENEOUS REACTORS. D'Amico, Giorgio (Applicazioni e Ricerche Scientifiche, Milan). pp 203-6 of Fisica del Reattore. Rome, Consiglio Nazionale delle Ricerche, 1966. (In Italian).

From Conference on Physics of Reactors, Milan. See CONF-469.

Calculational techniques for heterogeneous reactors are discussed. Group theory applications to reactor kinetics equations are described. Use of computers for iterative solutions for kernel and finite difference methods is described briefly. (M.L.S.)

50862 METHODS FOR SOLVING THE NEUTRON DIFFUSION EQUATIONS. Galligani, Ilio (EURATOM, Ispra, Italy). pp 207-16 of Fisica del Reattore. Rome, Consiglio Nazionale delle Ricerche, 1966. (In Italian).

From Conference on Physics of Reactors, Milan. See CONF-469.

Methods for solution of homogeneous and nonhomogeneous diffusion equations are discussed. Assumptions for the solution of homogeneous equations are listed; the diffusion equations are reduced to a nonzero system of linear algebraic equations for easier solution. Methods of treatment of the elliptic equations arising when considering nonhomogeneous diffusion equations are described briefly. (M.L.S.)

50863 ITERATIVE-VARIATIONAL METHODS FOR NUMERICAL SOLUTION TO ELLIPTICAL PROBLEMS IN REACTOR THEORY. Albertoni, Sergio; Lunelli, Massimiliano; Maggioni, Gabriella (Applicazioni e Ricerche Scientifiche, Milan). pp 217-22 of Fisica del Reattore. Rome, Consiglio Nazionale delle Ricerche, 1966. (In Italian).

From Conference on Physics of Reactors, Milan. See CONF-469.

Methods for iterative-variational techniques for solution of u-dimensional diffusion equations for heterogeneous systems are described. Use of this technique as a basis for a computer program is discussed. (M.L.S.)

50864 METHODS OF ANALYTICAL RESOLUTION OF ONE-GROUP TWO-DIMENSIONAL MANY REGION DIFFUSION EQUATIONS. Bruschi, Colombo; Pierini, Giancarlo; Rubbia, Silvio (CISE, Milan). pp 223-32 of Fisica del Reattore. Rome, Consiglio Nazionale delle Ricerche, 1966. (In Italian).

From Conference on Physics of Reactors, Milan. See CONF-469.

Analytical methods for the calculation of neutron flux using one-dimensional, multiregion, two-group methods are described. Direct and semidirect methods for solution to the characteristic diffusion equations are outlined. Matrix notation is used to formulate analytical expressions for the neutron flux. (M.L.S.)

50865 SELF-CONSISTENT APPROACH TO HETEROGENEOUS REACTOR PHYSICS. Corno, Silvio (Univ., Pavia, Italy. AGIP Nucleare, Milan). pp 181-201 of Fisica del Reattore. Rome, Consiglio Nazionale delle Ricerche, 1966.

From Conference on Physics of Reactors, Milan. See CONF-469.

A self-consistent criticality calculation for heterogeneous reactor physics analysis is described. The problem of evaluating, by means of a heterogeneous exponential experiment, the reaction parameters of a given neutron multiplying block is examined. The theory is developed for an experiment involving only a single fuel element. (H.D.R.)

50866 CONTROL RODS: COMPARISON OF SEVERAL METHODS FOR CALCULATIONS. Zamparo, Giuseppe (Univ., Genoa. ACF Industries, Inc., Washington, D. C.). pp 131-58 of Fisica del Reattore. Rome, Consiglio Nazionale delle Ricerche, 1966. (In Italian).

From Conference on Physics of Reactors, Milan. See CONF-469.

The various methods for calculation of control rod effects are summarized. A brief evaluation of each method is given. Effects on core reactivity of control rods are determined for cores with and without reflectors. Critical buckling is determined using the different techniques. The equations for the Nordheim–Scalettar, Murray, Murray and Price, and Garabedian techniques are listed. (M.L.S.)

50867 METHODS OF NEUTRONIC CALCULATIONS BY MEANS OF A IBM-704 COMPUTER. Cambrisi, Ermanno; Trombetti, Tullio; Vignoli, Paola (CNEN, Bologna). pp 63-9 of Fisica del Reattore. Rome, Consiglio Nazionale delle Ricerche, 1966. (In Italian).

From Conference on Physics of Reactors, Milan. See CONF-469.

A discussion of the various types of FORTRAN codes, which are available for core neutronics calculations, is given. Mathematical methods used for flux and adjoint flux calculations are discussed. Sample calculations are given; prompt reactivity and neutron population are shown as a function of time. 14 references. (M.L.S.)

50868 SOME EXPERIENCE WITH FITTING INDIRECT THERMAL CROSS SECTIONS TO A WIGNER–WILKINS SPECTRUM. Buffoni, Giuseppe; Loizzo, Paolo; Norelli, Francesco (CNEN, Rome). pp 261-75 of Fisica del Reattore. Rome, Consiglio Nazionale delle Ricerche, 1966. (In Italian).

From Conference on Physics of Reactors, Milan. See CONF-469.

Use of the Wigner–Wilkins method for spectral fitting of reactor neutron fluxes is described. A description of SCRAP, a linear regression program for calculation of polynomial coefficients for solution to reactor kinetics equations, is given. Numerical techniques used in spectral fitting are evaluated; effects of variations and errors are analyzed. ^{241}Am is used as an example; calculations and errors are tabulated. (M.L.S.)

50869 NUCLEAR CODES FOR THE ELEA 6001. Galligani, Ilio (Applicazioni e Ricerche Scientifiche, Milan); Giannini, Marcello; Gianolio, Laura. pp 289-93 of Fisica del Reattore. Rome, Consiglio Nazionale delle Ricerche, 1966. (In Italian).

From Conference on Physics of Reactors, Milan. See CONF-469.

Use of the ELEA 6001 computer for reactor calculations is summarized. Calculations of macroscopic constants in the thermal zone are outlined; fast and epithermal constants calculations are discussed. Spectral determinations in infinite homogeneous media are described; calculation of time-varying parameters is outlined. (M.L.S.)

50870 STATISTICAL METHOD FOR THE CALCULATION OF ENGINEERING FACTORS OF HOT CHANNELS. Pozzi, Gian Paolo (FIAT, Turin). pp 295-307 of Fisica del Reattore. Rome, Consiglio Nazionale delle Ricerche, 1966. (In Italian).

From Conference on Physics of Reactors, Milan. See CONF-469.

Methods for core thermal-hydraulic calculations are discussed. Statistical methods utilized previously are described. A hot spot method is proposed as a calculational model; this is described. The computerization of the hot spot method, utilizing Monte Carlo techniques, is discussed; results are shown graphically. (M.L.S.)

50871 CONSIDERATIONS ON THE FAST-THERMAL REACTOR RB-3 AT ZERO POWER. Azzoni, Piero; Melandri, Anna Maria; Meneghetti, David; Pierantoni, Ferrante (CNEN, Bologna). pp 361-72 of Fisica del Reattore. Rome, Consiglio Nazionale delle Ricerche, 1966. (In Italian).

From Conference on Physics of Reactors, Milan. See CONF-469.

Results of preliminary calculations for a fast-thermal zero power reactor (RB-3) are given. Core characteristics are tabulated for $^{233}U/ThO_2$ and $^{235}U/ThO_2$; critical masses of fissile and fertile materials are tabulated. Spectral indices are listed for various core volumes. General design considerations are discussed. 12 references. (M.L.S.)

50872 REMOVAL OF RADIOIODINE VAPOR BY CHARCOAL FILTERS. Kitani, Susumu; Tanaka, Tochiyuki (Japan Atomic Energy Research Inst., Tokyo). Kuki Seijo, 5: No. 6, 25-31(Mar. 1968). (In Japanese).

A filtration-adsorption system is installed in a ventilation exhaust of the reactor building for confinement of radioactive aerosols and iodine vapor that might be released in the event of a reactor accident. The system consists of demisters, prefilters, high-efficiency air filters, and charcoal filters. Recent work on the use of charcoal filters for the removal of radioiodine vapor is reviewed. The retention efficiency of iodine on activated carbon is discussed as a function of grain-size of activated carbon, flow rate of carrier gas, humidity, concentration of iodine vapor, and column length. For practical use, charcoal filters in position should be periodically tested to ensure filter bypass paths have not developed and activated carbon has not deteriorated. The nondestructive test method was developed in Japan Atomic Energy Research Institute and Savannah River Laboratory. Some discussion is given of engineering aspects of the manufacture and installation of the charcoal filters. (auth)

50873 OPTIMAL POWER REDUCTION IN A THERMAL NUCLEAR REACTOR. Arienti, G. (CNR, Rome); Daneri, A. Colonelli; Kenneth, P. Energ. Nucl., 15: 637-42(Oct. 1968).

A direct numerical method is proposed in order to obtain the optimal strategy for the power reduction in a thermal nuclear reactor in an assigned time, taking into account the xenon poisoning. The variables are subjected to suitable constraints imposed by the reactor behavior. 8 references. (auth)

50874 NUCLEAR REACTOR FUEL ELEMENT. Notari, G. V.; Grubelich, F. T. (to United States Atomic Energy Commission). U. S. Patent 3,346,461. Oct. 10, 1967.

A nuclear reactor multi-pass fuel element is described wherein the fluid to be heated continuously increases in temperature as it traverses the fuel element. The fuel element includes multiple tubes that extend between and are interconnected with common tube sheets. (auth)

50875 REACTOR CONTROL BY FREE PINION RACK AND PINION LINEAR ACTUATOR MOTION MULTIPLIER. Barrus, Donald M.; Williams, Ardell C. (to United States Atomic Energy Commission). U. S. Patent 3,405,032. Oct. 8, 1968.

A mechanism is described in which floating pinions operate between a system of fixed and movable racks to provide motion multiplication which is highly advantageous for systems such as control rod drives for nuclear reactors. (auth)

50876 FUEL ELEMENT HANDLING EQUIPMENT FOR A NUCLEAR REACTOR. Grouthier, Jean; Pellerin, Achille (to Commissariat a l'Energie Atomique). British Patent 1,129,062. Oct. 2, 1968. Priority date Apr. 7, 1966, France.

A reactor loading machine is described which consists of a chain-drive gripper device. The chain-drive consists of multiple rigid links which are pivotally connected. The chain is stored in a magazine in a wound configuration. Each link of the chain contains roller bearings which engage the threads of a rotating screw. The screw actuates the movements in the chain-drive. (D.C.C.)

50877 SPACER FOR FUEL ELEMENTS OF NUCLEAR REACTORS. (to Licentia Patent Verwaltungs-GmbH). British Patent 1,129,103. Oct. 2, 1968. Priority date Jan. 21, 1965, Germany.

A spacing system for multiple elongated cylindrical fuel elements is described. The spacing system consists of lattice forming members with alternating fixed and resilient components. The fixed members are formed from pressed-out dimples. The resilient members are strip-like springs. A frame surrounds the entire lattice. (D.C.C.)

50878 IMPROVEMENTS IN OR RELATING TO HEAT EXCHANGERS FOR STEAM GENERATION PARTICULARLY FOR USE IN NUCLEAR POWER PLANTS. Krizek, Vladimir (to Prvni Brnenska Strojirna, Zavody Klementa Gottwalda, Narodni Podnik). British Patent 1,128,927. Oct. 2, 1968. Filed Nov. 2, 1965.

A nuclear reactor heat exchanger is described. The heat exchanger consists of multiple vertical parallel rows of elements with inner bundles of tubes. Water or steam flows through the inner bundle as a heat absorbing fluid. (D.C.C.)

50879 AN EXPERIMENTAL INVESTIGATION OF SPATIAL EFFECTS ON THE NEUTRON FLUCTUATION SPECTRA OF A LARGE NUCLEAR REACTOR. Buhl, Anthony Ray. Knoxville, Tenn., Univ. of Tennessee, 1967. 155p.

Thesis.

Experiments were performed on the 305 Test Pile at the Savannah River Plant to determine the spatial effects on the neutron fluctuation spectra of a large nuclear reactor. Spectra were obtained with two detectors at various positions within a horizontal hole which passes through the center of the reactor. For these experiments, the reactor was slightly subcritical (30 cents). A digital data reduction code SEN was developed to correct for the finite filter resolution. The method used is to least squares fit a convolution of the filter function with an analytic form of the zero-resolution spectrum to the experimental data. The corrected spectra from SEN were compared with space-dependent spectra calculated using a formulation by M. Natelson, and also with spectra predicted by a simple space-independent model. This investigation indicates that, for the cases studied, the experimental spectra agree with both the space-dependent and the space-independent spectra when both detectors were within five migration lengths of the center of the reactor. Unexpected dips were observed in spectra for which one or both detectors were near the edge of the reactor core. Neither theory predicted this effect. The effect is believed to be due to the reflector. (Disser. Abstr.)

50880 THE APPLICATION OF VOLTERRA SERIES AND NONLINEAR OPERATORS TO NUCLEAR REACTOR KINETICS. Thierer, Ira. Gainesville, Fla., Univ. of Florida, 1967. 116p.

Thesis.

The analysis of nonlinear reactor systems through the use of solutions to the equations which are descriptive of the systems has been investigated. Two different methods of solution have been examined. The first, solution by Volterra series, deals with the system strictly in the time domain. The other method, nonlinear operator analysis, yields results in a multidimensional transform domain. The Volterra series solution for a reactor system is derived from the integral equation representation of the system and some of its properties are presented. For the method of analysis by operators, the appropriate algebra of operators is described and applied to a reactor system. Also, the concept of the multidimensional transform is presented. The response of a reactor system is found by a combination of the operator algebra with the transforms. Based on the operator method, some stability criteria are developed for systems with linear feedback. Based on comparison with simulated system response, the operator method is shown to give results of good accuracy. Some possible applications and extensions of the operator method are discussed. (Disser. Abstr.)

GENERAL

50881 (ANL–7408) COMPUTER ENVIRONMENT REPORT. Butler, M. K.; Rago, A. L.; Concaildi, George; Jordan, Donald; Kennedy, Allen S.; Krupp, Ronald F.; LeVee, Clifford; Ohde, John; Rempert, Roger; Robinson, George A. (Argonne National Lab., Ill.). Feb. 1968. Contract W-31-109-eng-38. 180p. Dep. CFSTI.

The Argonne computer environment report includes a description of the software systems and hardware devices for the IBM 360 and CDC 3600 and the peripheral and special purpose equipment. Copies of internal publications describing ANL-produced utility routines currently used by many of the computer programs and program systems prepared or developed at Argonne are included as appendices. (L.B.S.)

50882 (BNWL–838) A STATE-OF-THE-ART SURVEY OF LOW-LEVEL MULTIPLEXERS. Mahan, R. E. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Sept. 1968. Contract AT(45-1)-1830. 38p. Dep. CFSTI.

A comprehensive survey of the state-of-the-art in low-level multiplexers is presented. The study includes a literature search and a theoretical investigation followed by laboratory testing of equipment to support the theoretical investigation. The end result is intended to provide support for the preparation of a systems design description for the FFTF Central Control and Data Handling System. Electromechanical, FET, bipolar transistor, and amplifier-per-channel multiplexers are evaluated. (W.H.K.)

50883 (BNWL–SA–1724) STATUS OF CHINOOK SALMON SPAWNING IN THE HANFORD REACH OF THE COLUMBIA RIVER. Nakatani, R. E. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Mar. 15, 1967. Contract AT(45-1)-1830. 12p. Dep. CFSTI.

Evaluations of the biological effects of Hanford thermal discharges on the health of chinook salmon are summarized. A census of salmon spawning in the Hanford reach since 1947 shows an increase from a yearly average of 400 nests to an average of 3300 in 1967. The behavior of adult fish near reactor plumes was determined using sonic tags. The signal was tracked by the use of hydrophones in a boat. The data showed no temperature block of fish, but most fish migrated upstream along the opposite bank from reactor sites. Evidence indicated that routes of travel of migrating salmon are influenced by factors other than water temperature. Effects of heat increments on growth of young salmon and steelhead trout were studied; it was found that temperature increments exceeding 4°F above the base river temperature caused excessive mortality in the October spawn, but the December spawn tolerated an incremental addition as much as 12°F without significant mortality. Increased water temperatures accelerated growth in all lots. The importance of environmental factors other than temperature in determining the size of salmon population is emphasized. The temperature problem is discussed in relation to biological races composing spring, summer, and fall runs. Since each race possesses a gene pool evolved through selection, the genetic variation between individuals of a particular race gives resiliency to the race and determines the failure or success of the race to meet varying environmental temperatures. (H.L.W.)

50884 (COO–1469–79) COMPUTER SYSTEMS RESEARCH ANNUAL REPORT, SEPTEMBER 1, 1967–AUGUST 31, 1968. Gear, C. W.; Poppelbaum, W. J. (Illinois Univ., Urbana. Dept. of Computer Science). June 1968. 32p. Dep. CFSTI.

The graphic programming system using a remote graphic terminal on the ILLIAC II time-sharing system is described. Implementation of the numerical section for automatic integration of ordinary differential equations is briefly discussed. Also, development of the two advanced hybrid systems, the Tri-Color Cartograph and the Information Redistribution Bandwith Compression, is outlined. It has effectively become possible to color regions of a tri-color tube by pointing a light pen, and it has also become possible to reduce the bandwidth in the transmission of line drawings with less than 32 elements by a factor of over 10 without loss of definition. (W.H.K.)

50885 (CTC–2) RANKIN: A SUBROUTINE FOR THE CALCULATION OF THERMODYNAMIC PROPERTIES ALONG RANKINE CYCLES. Textor, Robin E. (Union Carbide Corp., Oak Ridge, Tenn. Computing Technology Center). Sept. 10, 1968. Contract W-7405-eng-26. 16p. Dep. CFSTI.

In order to accommodate a fairly wide range of thermodynamic problems in which Rankine cycles (or slight variations thereof) appear, a subroutine has been written which controls the calculation of thermodynamic properties and heat at the points of interest of such a cycle for which known information, such as enthalpy and entropy, can be utilized in any form convenient to the user. A listing of the subroutine (written in the IBM FORTRAN IV language) is included. (auth)

50886 (DP–1149) SIMULATION MODEL OF AN IBM 360/65 JOB SHOP. I. Knight, F. Delanoy; Ludeman, Michael M. (Du Pont de Nemours (E. I.) and Co., Aiken, S. C. Savannah River Lab.). Aug. 1968. Contract AT(07-2)-29801. 60p. Dep. CFSTI.

A discussion of a simulation model of an IBM 360/65 computer job shop (written in GPSS/360) is presented, with emphasis on the following points: a description of the system modeled, the GPSS model, the questions considered by the model, the design of the experiments made with the model, and the results obtained.

50887 (K–1755) THE ACCUMULATION OF DDT BY PARTICULATE AND DISSOLVED FRACTIONS OF NATURAL WATER. Lammers, William T. (Oak Ridge Gaseous Diffusion Plant, Tenn.). Oct. 2, 1968. Contract W-7405-eng-26. 17p. Dep. CFSTI.

The study of DDT distribution in natural water is essential to a better understanding of its true biohazards contributions in the aquatic environment. In order to determine this distribution and biohazards effect, the suspended materials must be isolated from natural water samples and studied. During the past two and one-half years such studies have been conducted in the Biophysical Limnology Laboratory at Oak Ridge whereby centrifugal techniques were used to isolate the particulate fractions contained in samples of DDT contaminated water. The isolated fractions were then studied analytically to determine the amount of DDT associated with each fraction. The reasons for making these studies were: one, to establish the feasibility of using centrifugal techniques for concentrating and isolating suspended materials from DDT contaminated water; two, to determine the pattern of DDT distribution within the major particulate fractions; and three, to check the effects of seasonal changes on the DDT distribution patterns. (auth)

50888 (MLM–1548(tr)) TORSION PENDULUM FOR THE CONTINUOUS RECORDING OF INTERNAL FRICTION. Salvi, A.; Dautreppe, D.; Friess, E. Translated by J. E. Selle (Mound Lab., Miamisburg, Ohio), from Compt. Rend., 258: 4039(1964). 8p. Dep. CFSTI.

An inverted torsion pendulum was oscillated at constant amplitude using a servomechanism. The mechanical oscillation modulated the frequency of two oscillators. A demodulator transformed this modulation to a voltage proportional to the amplitude. This amplified voltage supplied the coils which act on two magnets connected to the inertial wheel. The gain of the amplifier was automatically adjusted by an error signal obtained by comparing the input voltage of the amplifier to a reference voltage. (auth)

50889 (ORNL–4303) SOME TOPICS IN NUMERICAL ANALYSIS. Stewart III, G. W. (Oak Ridge National Lab., Tenn.). Sept. 1968. Contract W-7405-eng-26. 74p. Dep. CFSTI.

Thesis. Submitted to Univ. of Tennessee [Knoxville].

Two disjoint topics in numerical analysis are considered: Lehmer's method for solving algebraic equations and an acceleration procedure for the orthogonal iteration for the eigenvectors of a Hermitian matrix. Lehmer's method for finding a zero of a polynomial is a procedure for searching the complex plane in such a way that a zero is isolated in a sequence of disks of decreasing radii. Modifications of the method that improve its numerical stability are given. The asymptotic behavior of the method in the presence of rounding error is examined. The orthogonal iteration for finding invariant subspaces is a variant of Bauer's treppen-iteration. For a Hermitian matrix, it yields a set of dominant eigenvectors. However, the method converges slowly to eigenvectors corresponding to poorly separated eigenvalues. An acceleration procedure is proposed which yields a set of refined eigenvalues and eigenvectors. Error bounds for the refined eigenvalues and eigenvectors are derived. (auth)

50890 (RFP–1000) TRANSISTORIZED DIRECT CURRENT MOTOR CONTROL. Sheets, Warren R. (Dow Chemical Co., Golden, Colo. Rocky Flats Div.). Sept. 10, 1968. Contract AT(29-1)-1106. 6p. Dep. CFSTI.

A transistorized direct current motor control is described. The control has been installed on an electric platform-lift truck to permit continuous speed adjustment of both the hoist and travel motors. The control is designed to supply a maximum of 350 amperes from a 12-volt battery to a load consisting of a direct

current motor and current-limiting resistor. To adjust the speed of the two motors, potentiometers are used. The control circuit efficiency was found to exceed 80 percent. (auth)

50891 (RLO–1754-11) ACTIVE TRANSPORT AND METABOLISM OF FROG SKIN: EFFECT OF OUABAIN AND HYPEROSMOLARITY. Progress Report, September 1, 1966–August 31, 1967. Van Bruggen, John T. (Oregon Univ., Portland. Dept. of Biochemistry). May 31, 1967. Contract AT(45-1)-1754. 12p. Dep. CFSTI.

Active transport in the skin of frogs is explained on the basis of flux ratios of unity observed when raffinose is used as the hyperosmotic agent. It is concluded that an interaction between the hyperosmotic agent and other solutes may cause the flux ratio to exceed unity. Data from studies on frog skin and non-biological membranes that support this conclusion are presented. (H.G.D.)

50892 (STI/DOC–11(Vol.6)(No.2)) LIST OF BIBLIOGRAPHIES ON NUCLEAR ENERGY. (International Atomic Energy Agency, Vienna (Austria)). Aug. 1968. 37p. Dep.

References (147) are given for bibliographies on chemistry, earth sciences, engineering, instrumentation, physics, reactor technology, and other fields related to nuclear energy. (J.W.R.)

50893 (TID–3350) BIBLIOGRAPHIES OF INTEREST TO THE ATOMIC ENERGY PROGRAM, 1962–1966. Davis, Theodore F.; Smith, Richard J.; Voress, Hugh E.; Smelcer, Naomi K. (comps.) (Division of Technical Information Extension (AEC), Oak Ridge, Tenn.). Aug. 1968. 256p. Dep. CFSTI.

References with abstracts are given for 2001 bibliographies and literature surveys compiled from 1962 through 1966 that are related to atomic energy. Entries are categorized by subject, and appropriate cross references are provided. A report number index showing availability is included together with a corporate author index. (auth)

50894 (TID– 3748) BIBLIOGRAPHIES OF ATOMIC ENERGY LITERATURE. Issued or in Progress During the Period July–August 1968. (Division of Technical Information Extension (AEC), Oak Ridge, Tenn.). 12p. DTIE Free.

A list of 41 bibliographies received by DTI Extension in July and August, 1968 are included. Also, 40 bibliographies in preparation are listed. (W.H.K.)

50895 (TID–24585) APPLICATION OF SOME STATISTICAL TECHNIQUES TO THE STUDY OF EDDY STRUCTURE. Holland, Joshua Z. (Atomic Energy Commission, Washington, D. C.). Sept. 1968. 378p. Dep. CFSTI.

Thesis.

A system of computational techniques was developed to detect a variety of structural features in time series of fast-response meteorological data. The procedures were tested on 11 1-hr runs of 1-sec readings of u, v, w and T at 16 or 40 m at Round Hill, Massachusetts, and also on random noise data. After elimination of wild readings, each series was filtered into four bands containing periods roughly 10 min or longer, 1 to 10 min, 10 sec to 1 min, and less than 10 sec. First and second time derivatives, running variances and covariances representing time-varying high-frequency eddy energy and fluxes, and low-pass total velocity were computed at each filter period. Individual probability density functions and moments for each variable, joint density functions (JDF's) and moments for many pairs of variables, and conditional means of other variables as functions (CMF's) of each pair were computed in each band, and contour charts drawn for JDF's and CMF's. A smoothing function over 9 joint class intervals was used to suppress accidental irregularities, principally in the 1 to 10 min band. Linear and curvilinear dependences, skewness, peakedness, multimodality and other non-normal features were observed. The eddy kinetic energy, measured by the sum of the running variances of the three velocity components, showed a high-probability low-turbulence mode and one or more low-probability high-turbulence modes in most cases. The high-turbulence mode was associated with large long-period updrafts in thermal turbulence (unstable conditions) and was more pronounced at 40 than at 16 m. In mechanical turbulence (stable conditions) it was associated with large total velocity at 16 m, but much less so at 40 m. Secondary modes of heat and momentum flux were also observed under some conditions. CMF's of one of the turbulent variables ("reference variable") and its derivative can be considered a function of phase and amplitude of the fluctuations of the reference variable. Many variables were plotted as CMF's of probability-weighted phase angle of u or w. Their rates of change with the weighted phase of the reference variable agreed qualitatively with conditional mean time derivatives similarly computed. They thus serve as composite time-domain descriptions of the courses of the dependent variables during the fluctuation cycles of the reference variable within the filter band. A possible harmonic oscillation was shown by a hollow modal ring in JDF($\dot{w}$,w) in a stable case. Large-amplitude shifts from down- to updrafts, tentatively identified as passages of forward-rolling transverse vortices, are associated with large changes of u and T and with maxima of turbulent energy and heat and momentum flux, particularly in the 1 to 10 min band but also at 10 sec-1 min in stable conditions. Lulls, updrafts and high temperatures dominated the cycles of largest amplitude in unstable conditions, the opposite at small amplitude. In stable conditions the large-amplitude cycles were more symmetrical but at small amplitude u and T sometimes showed a counter-gradient relationship with w. (auth)

50896 (UCRL–50463) POCKELS CELLS: THEORY, TEST PROCEDURES, CHARACTERISTICS. Adams, W. E. (California Univ., Livermore. Lawrence Radiation Lab.). Aug. 1, 1968. Contract W-7405-eng-48. 33p. Dep. CFSTI.

To optimize the performance of a Pockels cell one must understand the basics of crystallography, optical birefringence, and the electro-optic effect. The pertinent information is scattered inconveniently throughout the literature and is rarely directed to the use and understanding of Pockels cells. The essential theory necessary to understand the Pockels effect is presented, and simple test procedures that will indicate the characteristics of the cell are described. Practical problems that one must consider when using a Pockels cell are discussed. (auth)

50897 (UCRL-50469) GASEOUS "SUBLIMATION" PRODUCTS OF SILICON MONOXIDE. Chambers, E. S.; Lee, E. L.; Morrison, R. D. (California Univ., Livermore. Lawrence Radiation Lab.). July 17, 1968. Contract W-7405-eng-48. 12p. Dep. CFSTI.

In an experiment, designed to examine the vapor composition from a typical silicon monoxide evaporation source, commercial silicon monoxide was sublimed from a resistively heated tantalum box (Mathis boat) with a small exit hole. The vapor beam passed through the ionizer of a quadrupole mass analyzer. In the 1200 to 1550°K range, ion currents were measured for Si^+, Si_2^+, O_2^+, SiO^+, $(SiO)_2^+$. The effusion rate of the sample was obtained by weighing the condensed vapor from the beam. From this and kinetic theory, the total vapor pressure of the sample was calculated, and thermochemical parameters were then calculated for the various species. A large discrepancy was found between the experimental and calculated pressures for the reaction $2\,SiO(g) \rightleftharpoons Si(g) + SiO_2(g)$. (auth)

50898 ISOTOPES AND RADIATION TECHNOLOGY. Volume 6, Number 1. Baker, P. S.; Lafferty, Robert H. Jr.; Carden, Joan E.; Gerrard, Martha; Greene, R. E.; McKinney, F. E.; Miller, F. J.; Rupp, A. F. (eds.). One of the Four Technical Progress Reviews Published for the Division of Technical Information, USAEC. Oak Ridge, Tenn., Oak Ridge National Lab., Fall 1968. 134p. GPO $0.70.

Separate abstracts were prepared for the eleven sections of the review. (B.S.L.)

For abstracts of individual sections see: 48835, 48855, 48887, 48930, 48994, 48995, 49032–49034, 49426, and 49670.

50899 HOW GREAT IS THE NUCLEAR FALL-OUT? Schabbeck, P. (Kienbaum Unternehmensberatung GmbH, Gummersbach, Ger.). Atomwirt., Atomtech., 13: 408-9(Aug.-Sept. 1968). (In German).

Developments in nuclear technology which have directly and indirectly influenced other areas of industry and science are examined. (H.D.R.)

50900 SELF CONSUMING COMPUTER PROGRAM FOR ON-LINE DATA PROCESSING. Rose, F. A. (Univ. of Wisconsin, Madison). Nucl. Instrum. Methods, 64: 229-30(Sept. 15, 1968).

A computer program, TADPOLE, used with an on-line computer, Honeywell DDP-124, which services the data collection needs of most of the tandem laboratory users is described. It provides only 2048 memory locations for data storage but by requesting more storage the user can cause the program to selectively destroy some of itself to provide up to 4608 data storage locations. (W.H.K.)

50901 FUNCTIONS OF A COMPLEX VARIABLE: CONSTRUCTIVE THEORY. Smirnov, V. I.; Lebedev, N. A. Cambridge, Mass., M.I.T. Press, 1968. 495p.

Translated from Konstruktivnaya Teoriya Funktsii Kompleksogo Peremennogo by Scripta Technica Ltd., London.

The approximate representation of functions of a certain class by functions of a sub-class which are in some sense simpler is discussed for the case of regular functions of a complex variable. The estimation of the given class of functions is also considered. (D.C.W.)

Appendix I

JOURNAL LIST

The following list includes 1968 additions to the comprehensive list published in NSA, Volume 22, No. 1, January 15, 1968. In the future, comprehensive lists will be published once each year (in January), and current additions will be cumulated on a monthly basis (in alternate issues) until the next comprehensive list is issued.

The title abbreviations are based on the United States of America Standards Institute's REVISED AND ENLARGED WORD-ABBREVIATION LIST FOR USASI Z39.5–1963 AMERICAN STANDARD FOR PERIODICAL TITLE ABBREVIATIONS. Titles of journals that are scanned regularly for NUCLEAR SCIENCE ABSTRACTS are marked by an asterisk (*). Foreign-language journals identified by a dagger (†) are available in English translation. The original-language title for a translated journal is given in parenthesis after the English title.

Accounts Chem. Res.
*Accounts of Chemical Research *(U. S.)*

Acta Anat. Nippon.
Acta Anatomica Nipponica
see *Kaibogaku Zasshi*

Acta Astron.
Acta Astronomica, Polska Akademia Nauk (formed by merger of Acta Astronomica, Ser. A; Ser. B; and Ser. C) *(Poland)*

Acta Chir. Scand., Suppl.
Acta Chirurgica Scandinavica, Supplementum *(Sweden)*

Acta Cient. Venez., Supl.
Acta Cientifica Venezolana, Suplemento *(Venezuela)*

Acta Clin. Belg.
Acta Clinica Belgica *(Belgium)*

Acta Dermatol.
Acta Dermatologica
see *Hifuka Kiyo*

Acta Entomol. Bohemoslov.
Acta Entomologica Bohemoslovaca *(Czechoslovakia)*

Acta Geod., Geophys. Montanistica
Acta Geodaetica, Geophysica et Montanistica *(Hungary)*

Acta Med. Iugoslav.
Acta Medica Iugoslavica *(Yugoslavia)*

Acta Med. Nosocomi Sapporo
Acta Medica Nosocomi Sapporo
see *Shiritsu Sapporo Byoin Ishi*

Acta Paediat. Jap.
Acta Paediatrica Japonica
see *Nippon Shonika Gakkai Zasshi*

Acta Pharm. Hung.
Acta Pharmaceutica Hungarica *(Hungary)*

Acta Pharm. Suec.
Acta Pharmaceutica Suecica *(Sweden)*

Acta Phys. Chem.
*Acta Physica et Chemica *(Hungary)*

Acta Phytopathol. (Budapest)
Acta Phytopathologica Academiae Scientiarum Hungaricae (Budapest) *(Hungary)*

Acta Polytech., Chem. Met. Ser.
Acta Polytechnica, Chemistry including Metallurgy Series *(Sweden)*

Acta Sch. Med. Gifu
Acta Scholae Medicinalis in Gifu
see *Gifu Ika Daigaku Kiyo*

Acta Sci. Natur. Univ. Pekin.
Acta Scientiarum Naturalium Universitatis Pekinensis
see *Pei Ching Ta Hsueh Hsueh Pao, Tzu Jan K'o Hsueh*

Acta Sci. Natur., Univ. Szechuan.
Acta Scientiarum Naturalium, Universitatis Szechuanensis
see *Ssu Ch'uan Ta Hsueh Hsueh Pao–Tzu Jan K'o Hsueh*

Acta Tuberc. Pneumol. Belg.
Acta Tuberculosea et Pneumologica Belgica *(Belgium)*

Acta Univ. Carolinae, Med., Monogr.
Acta Universitatis Carolinae, Medica, Monographia *(Czechoslovakia)*

Acta Univ. Nankinensis Sci. Natur.
Acta Universitatis Nankinensis Scientiarum Naturalium
see *Nan Ching Ta Hsueh Hsueh Pao, Tzu Jan K'o Hsueh*

Acta Univ. Upsaliensis, Abstr. Upsala Diss. Sci.
Acta Universitatis Upsaliensis, Abstracts of Uppsala Dissertations in Science *(Sweden)*

Acta Urol. Jap.
Acta Urologica Japonica
see *Hinyokika Kiyo*

Actual. Hepato-Gastro-Enterol. Hotel-Dieu
Actualites Hepato-Gastro-Enterologiques de l'Hotel-Dieu *(France)*

Advan. Colloid Interface Sci.
Advances in Colloid and Interface Science *(Netherlands)*

Advan. Contr. Syst.
Advances in Control Systems *(U. S.)*

Advan. Cryog. Eng.
Advances in Cryogenic Engineering *(U. S.)*

Advan. Lipid Res.
Advances in Lipid Research *(U. S.)*

Advan. Nucl. Phys.
Advances in Nuclear Physics *(U. S.)*

Advan. Polym. Sci.
Advances in Polymer Science
see *Fortschr. Hochpolym.-Forsch.*

Advan. X-Ray Anal.
Advances in X-Ray Analysis *(U. S.)*

Aesthet. Med.
Aesthetische Medizin *(West Germany)*

Agra Univ. J. Res., Part 3
Agra University Journal of Research, Part 3. Science *(India)*

Agr. Eng.
Agricultural Engineering *(U. S.)*

Agr. Hokkaido
Agriculture in Hokkaido
see *Hokuno*

Agr. Hort. (Tokyo)
Agriculture and Horticulture (Tokyo)
see *Nogyo Oyobi Engei*

Agricultura (Lisbon)
Agricultura (Lisbon) *(Portugal)*

Agriculture (Paris)
Agriculture (Paris) *(France)*

Agr. Res. (New Delhi)
Agricultural Research (New Delhi) *(India)*

Air Clean.
Air Cleaning
see *Kuki Seijo*

Air Water Pollut.
Air and Water Pollution (formerly International Journal of Air Water Pollution) *(U. S.–England)*

Ala. J. Med. Sci.
Alabama Journal of Medical Sciences, The *(U. S.)*

Allg. Prakt. Chem.
Allgemeine und Praktische Chemie *(Austria)*

Allg. Waermetech.
Allgemeine Waermetechnik *(West Germany)*

Alloy Dig. Zr-3
Alloy Digest Zr-3 *(U.S.)*

Amer. Ass. Petrol. Geol. Bull.
American Association of Petroleum Geologists Bulletin *(U. S.)*

Amer. Dyestuff Rep.
American Dyestuff Reporter *(U. S.)*

Amer. Eng.
American Engineer *(U. S.)*

Amer. J. Med. Technol.
American Journal of Medical Technology *(U. S.)*

Amer. Mach./Metalwork. Mfg.
American Machinist/Metalworking Manufacturing *(U. S.)*

Amino Acid Nucl. Acid
Amino Acid and Nucleic Acid
see **Hakko To Taisha**

Anaesthesist
Anaesthesist *(West Germany)*

Anal. Lett.
Analytical Letters *(U. S.)*

An. Lactol. Quim. Agr. Zaragoza
Anales de Lactologia y Quimica Agricola de Zaragoza *(Spain)*

Ann. Abeille
Annales de l'Abeille *(France)*

Ann. Acad. Sci. Fenn., Ser. A IV
Annales Academiae Scientiarum Fennicae, Series A IV *(Finland)*

Ann. Bot. Fenn.
Annales Botanici Fennici *(Finland)*

Ann. Dent.
Annals of Dentistry *(U. S.)*

Ann. Ist. Carlo Forlanini
Annali dell'Istituto Carlo Forlanini *(Italy)*

Ann. Med. Vet.
Annales de Medicine Veterinaire *(Belgium)*

Ann. Oto-Laryngol.
Annales d'Oto-Laryngologie *(France)*

Annot. Zool. Jap.
*Annotationes Zoologicae Japonenses *(Japan)*

Ann. Phytopathol. Soc. Jap.
Annals of the Phytopathological Society of Japan
see **Nippon Shokubutsu Byori Gakkaiho**

Ann. Ponts Chaussees
Annales des Ponts et Chaussees *(France)*

Ann. Sanita Pubblica
Annali della Sanita Pubblica *(Italy)*

Annu. ISA (Instrum. Soc. Amer.) Conf. Proc.
Annual ISA (Instrument Society of America) Conference Proceedings *(U. S.)*

Ann. Univ. Mariae Curie-Sklodowska, Lublin-Pol., Sect. DD
*Annales Universitatis Mariae Curie-Sklodowska, Lublin-Polonia, Sectio DD *(Poland)*

Ann. Univ. Sci. Budapest. Rolando Eotvos Nominatae, Sect. Geol.
*Annales Universitatis Scientiarum Budapestinensis de Rolando Eotvos Nominatae, Sectio Geologica *(Hungary)*

Annu. Rep. Lab. Public Health, Hiroshima Prefect.
Annual Report of the Laboratory of Public Health, Hiroshima Prefecture
see **Hiroshima Ken Eisei Kenkyushoho**

Annu. Rep. Res. Inst. Environ. Med., Nagoya Univ.
Annual Report of the Research Institute of Environmental Medicine, Nagoya University *(Japan)*

Annu. Rep. Res. Inst. Tuberc., Kanazawa Univ.
Annual Report of the Research Inst. of Tuberculosis, Kanazawa University
see **Kanazawa Daigaku Kekkaku Kenkyusho Nenpo**

Annu. Rep. Sankyo Res. Lab.
Annual Report of Sankyo Research Laboratory
see **Sankyo Kenkyusho Nenpo**

Annu. Rep. Shionogi Res. Lab.
Annual Report of Shionogi Research Laboratory
see **Shionogi Kenkyusho Nenpo**

Annu. Rev. Genet.
Annual Review of Genetics *(U.S.)*

An. Stiint. Univ. Al. I. Cuza, Iasi, Sect. I
Analele Stiintifice ale Universitatii Al. I. Cuza, din Iasi, Sectiunea I *(Romania)*

An. Stiint. Univ. Al. I. Cuza Iasi, Sect. Ib. Fiz.
Analele Stiintifice ale Universitatii Al. I. Cuza din Iasi, Sectiunea Ib. Fizica *(Romania)*

Antimicrob. Agents Chemother.
Antimicrobial Agents and Chemotherapy *(U. S.)*

An. Univ. Bucuresti, Ser. Stiint. Natur., Fiz.
Analele Universitatii Bucuresti, Seria Stiintele Naturii, Fizica *(Romania)*

Apicultura (Bucharest)
Apicultura (Bucharest) *(Romania)*

Arbeitsgemeinsch. Forsch. Landes Nordrhein-Westfalen
Arbeitsgemeinschaft fuer Forschung des Landes Nordrhein-Westfalen *(West Germany)*

Arbeitsmed.-Sozialmed.-Arbeitshyg.
Arbeitsmedizin-Sozialmedizin-Arbeitshygiene *(West Germany)*

Arch. Chir. Neer.
Archivum Chirurgicum Neerlandicum *(Netherlands)*

Arch. Hist. Exact. Sci.
Archive for History of Exact Sciences *(West Germany—U. S.)*

Arch. Inst. Farmacol. Exp. (Madrid)
Archivos del Instituto de Farmacologie Experimental (Medicina) (Madrid) *(Spain)*

Arch. Jap. Chir.
Archiv fuer Japanische Chirurgie
see **Nippon Geka Hokan**

Arch. Klin. Exp. Ohren-, Nasen- Kehlkopfheilk.
Archiv fuer Klinische und Experimentelle Ohren-, Nasen- und Kehlkopfheilkunde *(West Germany)*

Arch. Mal. Prof. Med. Trav. Secur. Sociale
Archives des Maladies Professionnelles de Medicine du Travail et de Securite Sociale *(France)*

Arch. Meteorol., Geophys. Bioklimatol., Ser. B
Archive fuer Meteorologie, Geophysik und Bioklimatologie, Series B *(Austria)*

Arch. Mineral.
Archiwum Mineralogiczne *(Poland)*

Arch. Neer. Sci. Exactes Natur.
Archives Neerlandaises des Sciences Exactes et Naturelles *(Netherlands)*

Arch. Phys. Ther.
Archiv fuer Physikalische Therapie, Balneologie und Klimatologie *(East Germany)*

Arch. Sci. (Geneva)
Archives des Sciences (Geneva) *(Switzerland)*

Arch. Stomatol.
Archivio Stomatologico *(Italy)*

Ark. Zool.
Arkiv for Zoologi, Utgivet av Kungl. Svenska Vetenskapsakademien *(Sweden)*

ASM (Amer. Soc. Metals), Trans. Quart.
*ASM (American Society for Metals), Transactions Quarterly (formerly Transactions of the American Society for Metals) *(U. S.)*

ASTM (Amer. Soc. Test. Mater.) Spec. Tech. Publ.
ASTM (American Society for Testing and Materials) Special Technical Publication *(U. S.)*

Astrofizika
Astrofizika *(Armenian S.S.R.)*

Astron. Tsirk.
Astronomicheskii Tsirkulyar *(U.S.S.R.)*

Astrophysics (Engl. Transl.)
*Astrophysics (English Translation of Astrofizika) *(U. S.)*

Astrophys. Lett.
*Astrophysical Letters *(Scotland)*

Astrophys. Space Sci.
*Astrophysics and Space Science *(Netherlands)*

At. Absorption Newslett.
Atomic Absorption Newsletter *(U. S.)*

Ateneo Parmense, Sez. 1
Ateneo Parmense, Sezione 1. Acta Bio-Medica *(Italy)*

At. Energy (China)
Atomic Energy (China)
see **Yuan Tzu Neng**

At. Energy Bull.
Atomic Energy Bulletin
see **Genshiryoku Shiryo**

At. Energy Law J.
Atomic Energy Law Journal *(U. S.)*

Atomes (Paris)
Atomes (Paris) *(France)*

Atmos. Environ.
*Atmospheric Environment *(England)*

Atti Accad. Med. Lombarda
Atti della Accademia Medica Lombarda *(Italy)*

Aust. J. Exp. Agr. Anim. Husb.
Australian Journal of Experimental Agriculture and Animal Husbandry *(Australia)*

Aust. J. Mar. Freshwater Res.
Australian Journal of Marine and Freshwater Research *(Australia)*

Aust. J. Zool.
Australian Journal of Zoology *(Australia)*

Aust. Mach. Prod. Eng.
Australian Machinery and Production Engineering *(Australia)*

Australas. Mfr.
Australasian Manufacturer *(Australia)*

Automat. Electron.
Automatica si Electronica *(Romania)*
Automaz. Strum.
Automazione e Strumentazione *(Italy)*
Aviat. Week Space Technol.
Aviation Week and Space Technology *(U. S.)*
Bautechnik
Bautechnik, Die *(West Germany)*
Beitr. Biol. Pflanz.
Beitraege zur Biologie der Pflanzen *(West Germany)*
Bendix Tech. J.
Bendix Technical Journal *(U. S.)*
Ber. Deut. Ges. Geol. Wiss., Reihe B
Berichte der Deutschen Gesellschaft fuer Geologische Wissenschaften, Reihe B. Mineralogie und Lagerstaettenforschung *(East Germany)*
Berg- Huettenmaenn. Monatsh. Montan. Hochsch. Leoben
Berg- und Huettenmaennische Monatschefte der Montanistischen Hochschule in Leoben *(West Germany)*
Berlin. Wetterkarte, Suppl.
Berliner Wetterkarte, Supplement *(West Germany)*
Ber. Schweiz. Bot. Ges.
Berichte der Schweizerischen Botanischen Gesellschaft *(Switzerland)*
Beton Zhelezobeton
Beton i Zhelezobeton *(Georgian S.S.R.)*
Biochem. Med.
Biochemical Medicine *(U. S.)*
Biol. Nauki
Biologicheskie Nauki *(U.S.S.R.)*
Biol. Plant., Acad. Sci. Bohemoslov.
Biologia Plantarum, Academia Scientarum Bohemoslovenica *(Czechoslovakia)*
Biol. Rundsch.
Biologische Rundschau *(East Germany)*
Bioscience
Bioscience *(U. S.)*
Biul. Wojsk. Akad. Tech.
Biuletyn Wojskowej Akademii Techniczenj imeni Jaroslawa Dabrowskiego *(Poland)*
Blech
Blech *(West Germany)*
BNX Rev.
*BNX Review *(England)*
Bodenkultur
Bodenkultur, Die *(Austria)*
Boll. Inst. Entomol. Agr. Osserv. Fitopatol. Palermo
Bollettino dell'Istituto di Entomologia Agraria e dell'Osservatorio di Fitopatologia di Palermo *(Italy)*
Boll. Lab. Chim. Prov. (Bologna)
Bollettino dei Laboratori Chimici Provinciali (Bologna) *(Italy)*
Boll. Soc. Ital. Cardiol.
Bollettino della Societa Italiana di Cardiologia *(Italy)*
Boll. Zool.
Bollettino di Zoologia. Pubblicato dall'Unione Zoologica Italiana *(Italy)*
Bol. Univ. Fed. Parana, Fis. Teor.
*Boletim da Universidade Federal do Parana, Fisica Teorica *(Brazil)*
Bot., Issled., Beloruss. Otd. Vses. Bot. Obshchest.
Botanika, Issledovaniya, Belorusskoe Otdelenie Vsesoyuznogo Botanicheskogo Obshchestva *(Belorussian S.S.R.)*
Bot. Mag. (Tokyo)
Botanical Magazine, The (Tokyo) *(Japan)*
Brain Res.
Brain Research *(Netherlands)*
Brit. Food J.
British Food Journal *(England)*
Brit. J. Dis. Chest
British Journal of Diseases of the Chest *(England)*
Brit. J. Plast. Surg.
British Journal of Plastic Surgery *(Scotland)*
Brit. Mycol. Soc. Trans.
British Mycological Society Transactions, The *(England)*
Brit. Plast.
*British Plastics *(England)*
Broad Way Clin. Suppl.
Broad Way Clinical Supplement *(England)*
Build. Eng.
Building Engineering
see Kenchiku Gijutsu
Bul. Inst. Politeh. Gheorghe Gheorghiu-Dej Bucuresti
Buletinul Institutului Politehnic Gheorghe Gheorghiu-Dej Bucuresti *(Romania)*
Bull. Astron.
Bulletin Astronomique *(France)*
Bull. Astron. Inst. Neth.
Bulletin of the Astronomical Institutes of the Netherlands *(Netherlands)*
Bull. Astron. Inst. Neth., Suppl. Ser.
Bulletin of the Astronomical Institutes of the Netherlands, Supplement Series *(Netherlands)*
Bull. Belgicatom
Bulletin Belgicatom (formerly Belgicatom, Association Belge pour le Developpement Paficique de l'Energie Atomique, Bulletin d'Information) *(Belgium)*
Bull. Belg. Phys. Soc.
Bulletin of the Belgian Physical Society (formerly Bulletin de la Societe Belge de Physique) *(Belgium)*
Bull. Brew. Sci.
*Bulletin of Brewing Science *(Japan)*
Bull. Calcutta Math. Soc.
Bulletin of the Calcutta Mathematical Society *(India)*
Bull. Dir. Etud. Rech.
Bulletin de la Direction des Etudes et Recherches *(France)*
Bull. Earthquake Res. Inst., Univ. Tokyo
Bulletin of the Earthquake Research Inst., University of Tokyo
see Tokyo Daigaku Jishin Kenkyusho Iho
Bull. Eidgenoess. Gesundh., Beil. B
Bulletin des Eidgenoessisches Gesundheitsamtes, Beilage B *(Switzerland)*
Bull., Eng. Geol. Hydrogeol. (Engl. Transl.)
Bulletin, Engineering Geology and Hydrogeology (English Translation of Vesnik Zavoda za Geoloska i Geofizicka Istrazivanja, Serija B) *(Yugoslavia)*
Bull. Entomol. Res.
Bulletin of Entomological Research *(England)*
Bull. Fac. Agr., Hirosaki Univ.
Bulletin of the Faculty of Agriculture, Hirosaki University
see Hirosaki Daigaku Nogakubu Gakujutsu Hokoku
Bull. Fac. Agr., Mie Univ.
Bulletin of the Faculty of Agriculture, Mie University
see Mie Daigaku Nogakubu Gakujutsu Hokoku
Bull. Fac. Eng., Hiroshima Univ.
Bulletin of the Faculty of Engineering, Hiroshima University
see Hiroshima Daigaku Kogakubu Kenkyu Hokoku
Bull. Fac. Sci. Eng., Chuo Univ.
Bulletin of the Faculty of Science and Engineering, Chuo University
see Chuo Daigaku Rikogakubu Kiyo
Bull. Fed. Soc. Gynecol. Obstet. Langue Fr.
Bulletin de la Federation des Societes de Gynecologie et d'Obstetrique de Langue Francaise *(France)*
Bull. Geophys. Observ., Haile Sellassie I Univ.
Bulletin of the Geophysical Observatory, Haile Sellassie I University *(Ethopia)*
Bull. Govt. Ind. Res. Inst., Osaka
Bulletin of the Government Industrial Research Institute, Osaka
see Osaka Kogyo Gijutsu Shikenjo Kiho
Bull. Inform. A.T.E.N. (Ass. Tech. Energ. Nucl.), Suppl.
*Bulletin d'Information A.T.E.N. (Association Technique pour l'Energie Nucleaire), Supplement *(France)*
Bull. Inst. Geophys., Nat. Cent. Univ.
*Bulletin of the Institute of Geophysics, National Central University *(China (Taiwan))*
Bull. Inst. Int. Froid, Annexe
Bulletin de l'Institut International du Froid, Annexe *(France)*
Bull. Inst. Nat. Sante Rech. Med.
Bulletin de l'Institut National de la Sante et de la Recherche Medicale *(France)*
Bull. Instrum. Nucl.
*Bulletin Instrumentation Nucleaire (formerly Instrumentation Nucleiaire) Supplement au Bulletin d'Informations Scientifiques et Techniques *(France)*
Bull. Inst. Space Aeronaut. Sci., Univ. Tokyo
Bulletin of the Institute of Space and Aeronautical Science, University of Tokyo
see Tokyo Daigaku Uchu Koku Kenkyusho Hokoku
Bull Int. Inst. Refrig., Suppl.
Bulletin of the International Institute of Refrigeration, Supplement
see Bull. Inst. Int. Froid, Annexe
Bull. Kyoto Educ. Univ., Ser. B
Bulletin of the Kyoto Educational University, Series B. Mathematics and Natural Science *(Japan)*
Bull. Kyushu Inst. Technol., Math., Natur. Sci.
*Bulletin of the Kyushu Inst. of Technology, Mathematics, Natural Science *(Japan)*
Bull. Nat. Inst. Anim. Ind. (Jap.)
Bulletin of the National Inst. of Animal Industry (Japan)
see Chikusan Shikenjo Kenkyu Hokoku

Bull. Nat. Inst. Sci. India
Bulletin of the National Institute of Sciences of India *(India)*

Bull. Oerlikon
Bulletin Oerlikon *(Switzerland)*

Bull. Office Int. Epizoot.
Bulletin de l'Office International des Epizooties *(France)*

Bull. Osaka Munic. Tech. Res. Inst.
Bulletin of the Osaka Municipal Technical Research Inst.
see Osaka Shiritsu Kogyo Kenkyusho Hokoku

Bull. Res. Inst. Ferment., Yamanashi Univ.
Bulletin of the Research Inst. of Fermentation, Yamanashi University
see Yamanashi Daigaku Hakko Kenkyusho Kenkyu Hokoku

Bull. Res. Inst. Miner. Dressing Met., Tohoku Univ.
Bulletin of the Research Inst. of Mineral Dressing and Metallurgy, Tohoku University
see Tohoku Daigaku Senko Seiren Kenkyusho Iho

Bull. Res. Inst. Sci. Meas., Tohoku Univ.
Bulletin of the Research Institute for Scientific Measurement, Tohoku University
see Tohoku Daigaku Kagaku Keisoku Kenkyusho Hokoku

Bull. Soc. Roy. Bot. Belg.
Bulletin de la Societe Royale de Botanique de Belgique *(Belgium)*

Bull. Soc. Sea Water Sci., Jap.
Bulletin of the Society of Sea Water Science, Japan
see Nippon Kaisui Gakkaishi

Bull. Tulane Univ. Med. Fac.
Bulletin of the Tulane University Medical Faculty *(U.S.)*

Bull. Volcanol.
Bulletin Volcanologique *(Italy)*

Bull. Yamagata Univ., Natur. Sci.
Bulletin of the Yamagata University, Natural Science
see Yamagata Daigaku Kiyo, Shizenkagaku

Bul. Stiint. Teh. Inst. Politeh. Timisoara
Buletinul Stiintific si Tehnic al Institutului Politehnic Timisoara *(Romania)*

Bus. Rev., Univ. Wash.
Business Review, University of Washington *(U. S.)*

Bus. Syst. Equip.
Business Systems and Equipment *(England)*

Bus. Week
Business Week *(U. S.)*

Byggmesteren
Byggmesteren (Norges Byggforskningsinstitutt) *(Norway)*

Byull. Inst. Teor. Astron.
Byulleten Instituta Teoreticheskoi Astronomii *(U.S.S.R.)*

Byull. Kom. Opred. Absol. Geol. Form.
Byulleten Komissii po Opredeleniyu Absolyutnogo Vozrasta Geologicheskikh Formatsii *(U.S.S.R.)*

Byull. Mosk. Obshch. Ispyt. Prir., Otd. Biol.
Byulleten Moskovskogo Obshchestva Ispytatelei Prirody, Otdel Biologicheskii *(U.S.S.R.)*

Byull. Sov. Antarkt. Eksped.
Byulleten Sovetskoi Antarkticheskoi Ekspeditsii *(U.S.S.R.)*

CA–Cancer J. Clin.
CA– Cancer Journal Clinicians *(U.S.)*

Cah. Ing. Agron.
Cahiers des Ingenieurs Agronomes *(France)*

Cah. Oceanogr.
Cahiers Oceanographiques *(France)*

Calcified Tissue Res.
Calcified Tissue Research *(West Germany)*

Can. Hosp.
Canadian Hospital *(Canada)*

Can. J. Ophthalmol.
Canadian Journal of Ophthalmology *(Canada)*

Can. J. Psychol.
Canadian Journal of Psychology *(Canada)*

Can. Mach. Metalwork.
Canadian Machinery and Metalworking *(Canada)*

Canner/Packer
Canner/Packer *(U. S.)*

Can. Nurse
Canadian Nurse *(Canada)*

Catalyst (Tokyo)
Catalyst (Tokyo)
see Shokubai

Cell Tissue Kinet.
*Cell and Tissue Kinetics *(England)*

Celul. Hirtie
*Celuluza si Hirtie *(Romania)*

Cent. Afr. J. Med.
Central African Journal of Medicine *(Rhodesia)*

Cercet. Met.
Cercetari Metalurgice *(Romania)*

Cereal Sci. Today
Cereal Science Today *(U. S.)*

Chartered Mech. Eng.
Chartered Mechanical Engineer *(England)*

Chem. Age India
Chemical Age of India *(India)*

Chem. Eng., Jap.
Chemical Engineering, Japan
see Kagaku Kogaku

Chem. Fact. (Tokyo)
Chemical Factory (Tokyo)
see Kagaku Kojo

Chem. Heterocycl. Compounds (USSR) (Engl. Transl.)
Chemistry of Heterocyclic Compounds (USSR) (English Translation of Khimiya Geterotsiklicheskikh Soedinenii) *(U. S.)*

Chem. Instrum.
*Chemical Instrumentation *(U. S.)*

Chemotherapy (Tokyo)
*Chemotherapy (Tokyo) *(Japan)*

Chem. Pharm. Bull.
*Chemical and Pharmaceutical Bulletin *(Japan)*

Chem. Process. (London)
Chemical Processing (London) *(England)*

Chem. Rundsch. (Solothurn)
Chemische Rundschau (Solothurn) *(Switzerland)*

Chesapeake Sci.
Chesapeake Science *(U. S.)*

Chiba Igakkai Zasshi
*Chiba Igakkai Zasshi (The Journal of Chiba Medical Society) *(Japan)*

Chicago Med. Sch. Quart.
Chicago Medical School Quarterly *(U. S.)*

Chikusan Shikenjo Kenkyu Hokoku
*Chikusan Shikenjo Kenkyu Hokoku (Bulletin of the National Inst. of Animal Industry) *(Japan)*

Chikyu Kagaku
*Chikyu Kagaku (Earth Science) *(Japan)*

Chim. Ind., Genie Chim.
Chimie et Industrie, Genie Chimique (formed by the merger of Chimie et Industrie (Paris) and Genie Chimique (Paris)) *(France)*

Chin. Agr. Sci.
Chinese Agricultural Science
see Chung Kuo Nung Yeh K'o Hsueh

Chin. Anim. Husb. Vet. Med.
Chinese Animal Husbandry and Veterinary Medicine
see Chung Kuo Hsu Mu Shou I

Chin. J. Dermatol.
Chinese Journal of Dermatology
see Chung Hua P'i Fu K'o Tsa Chih

Chin. J. Gynecol. Obstet.
Chinese Journal of Gynecology and Obstetrics
see Chung Hua Fu Ch'an K'o Tsa Chih

Chin. J. Intern. Med.
Chinese Journal of Internal Medicine
see Chung Hua Nei K'o Tsa Chih

Chin. J. Phys. (Peking) (Engl. Transl.)
*Chinese Journal of Physics (Peking) (English Translation of Acta Physica Sinica (Wu Li Hsueh Pao)) *(U. S.)*

Chin. J. Physiol.
Chinese Journal of Physiology *(China)*

Chin. J. Surg.
Chinese Journal of Surgery
see Chung Hua Wai K'o Tsa Chih

Chromatographia
Chromatographia *(West Germany)*

Chung Hua Fu Ch'an K'o Tsa Chih
Chung Hua Fu Ch'an K'o Tsa Chih (Chinese Journal of Gynecology and Obstetrics) *(China)*

Chung Hua I Hsueh Tsa Chih
Chung Hua I Hsueh Tsa Chih (National Medical Journal of China) *(China)*

Chung Hua Nei K'o Tsa Chih
Chung Hua Nei K'o Tsa Chih (Chinese Journal of Internal Medicine) *(China)*

Chung Hua P'i Fu K'o Tsa Chih
Chung Hua P'i Fu K'o Tsa Chih (Chinese Journal of Dermatology) *(China)*

Chung Hua Wai K'o Tsa Chih
Chung Hua Wai K'o Tsa Chih (Chinese Journal of Surgery) *(China)*

Chung Kuo Hsu Mu Shou I
Chung Kuo Hsu Mu Shou I (Chinese Animal Husbandry and Veterinary Medicine) *(China)*

Chung Kuo Nung Yeh K'o Hsueh

Chung Kuo Nung Yeh K'o Hsueh (Chinese Agricultural Science) *(China)*

Chuo Daigaku Rikogakubu Kiyo
*Chuo Daigaku Rikogakubu Kiyo (Bulletin of the Faculty of Science and Engineering, Chuo University) *(Japan)*

CIM (Can. Mining Met.) Bull.
*CIM (Canadian Mining and Metallurgy) Bulletin (formerly Canadian Mining and Metallurgy Bulletin) *(Canada)*

Civil Eng. (N. Y.)
Civil Engineering (New York) *(U. S.)*

Civil Eng. Public Works Rev.
Civil Engineering and Public Works Review *(England)*

Clay Sci. (Tokyo)
*Clay Science (Tokyo) *(Japan)*

Cleveland Clin. Quart.
Cleveland Clinic Quarterly *(U. S.)*

Clin. Med.
Clinical Medicine *(U. S.)*

Clin. Orthop. Related Res.
Clinical Orthopaedics and Related Research (formerly Clinical Orthopaedics) *(U. S.)*

Coal Age
Coal Age *(U. S.)*

Cobalt
Cobalt *(France)*

Colloid J. (USSR) (Engl. Transl.)
Colloid Journal (USSR) (English Translation of Kolloidnyi Zhurnal) *(U. S.)*

Colloq. Int. Cent. Nat. Rech. Sci.
Colloques Internationaux du Centre National de la Recherche Scientifique *(France)*

Colo., Agr. Exp. Sta., Tech. Bull.
Colorado State University, Agricultural Experiment Station, Technical Bulletin *(U. S.)*

Colo. Sch. Mines, Miner. Ind. Bull.
Colorado School of Mines, Mineral Industries Bulletin *(U. S.)*

Combustion
Combustion *(U.S.)*

Commer. Fish. Rev.
Commercial Fisheries Review *(U. S.)*

Commun. Math. Phys.
Communications in Mathematical Physics *(West Germany)*

Compt. Rend. Ass. Anat.
Comptes Rendus de l'Association des Anatomistes *(France)*

Compt. Rend. Soc. Geol. Fr.
Compte Rendu Sommaire des Seances de la Societe Geologique de France *(France)*

Comput. Biomed. Res.
Computers and Biomedical Research *(U. S.)*

Concrete J.
Concrete Journal
see Konkurito Janaru

Constr. Masini
Constructia de Masini *(Romania)*

Constructor
Constructor *(U. S.)*

Coord. Chem. Rev.
Coordination Chemistry Reviews *(Netherlands)*

Cornell Vet., Suppl.
Cornell Veterinarian, Supplement *(U. S.)*

Corros. Prev. Contr.
Corrosion Prevention and Control *(England)*

Cuivre, Laitons, Alliages
Cuivre, Laitons, Alliages *(France)*

Curr. Awareness Bull.
Current Awareness Bulletin *(U. S.)*

Curr. Mod. Biol.
Currents in Modern Biology *(Netherlands)*

Czas. Stomatol.
Czasopismo Stomatologiczne *(Poland)*

Dallas Med. J.
Dallas Medical Journal *(U. S.)*

Dan. Med. Bull.
Danish Medical Bulletin *(Denmark)*

Del. Med. J.
Delaware Medical Journal *(U. S.)*

Denki Shikenjo Kenkyu Hokoku
*Denki Shikenjo Kenkyu Hokoku (Researches of the Electrotechnical Laboratory) *(Japan)*

Denryoku Chuo Kenkyusho Gijutsu Kenkyusho Hokoku
Denryoku Chuo Kenkyusho Gijutsu Kenkyusho Hokoku (Technical Laboratory, Central Research Institute of Electrical Power Industry, Report) *(Japan)*

Dermatol. Int.
Dermatologia Internationalis *(U. S.)*

Desalination
Desalination *(Netherlands)*

Des. Components Eng.
Design and Components in Engineering *(England)*

Deut. Apoth.-Ztg.
Deutsche Apotheker-Zeitung Vereinigt mit Sueddeutsche Apotheker-Zeitung *(West Germany)*

Deut. Hydrogr. Z.
Deutsche Hydrographische Zeitschrift *(West Germany)*

Deut. Zahn-, Mund- Kieferheilk.
Deutsche Zahn-, Mund- und Kieferheilkunde mit Zentralblatt fuer die Gesamte Zahn-, Mund- und Kieferheilkunde *(East Germany)*

Deut. Z. Gesam. Gerichtl. Med.
Deutsche Zeitschrift fuer die Gesamte Gerichtliche Medizin *(West Germany–U. S.)*

Diffus. Data
*Diffusion Data *(U. S.)*

DMIC Rev.
DMIC Review of Recent Developments *(U. S.)*

Doboku Gijutsu
*Doboku Gijutsu (Civil Engineering) *(Japan)*

Doc-Air-Espace
*Doc-Air-Espace *(France)*

Dokl.–Bot. Sci. Sect. (Engl. Transl.)
Doklady–Botanical Sciences Sections (English Translation) *(U.S.)*

Dokl. TSKhA (Timiryazev. Sel'skokhoz. Akad.)
Doklady TSKhA (Timiryazevskaya Sel'skokhozyaistvennaya Akademiya) *(U.S.S.R.)*

Dokl. Vses. Akad. Sel'skokhoz. Nauk
Doklady Vsesoyuznoi Akademii Sel'skokhozyaistvennykh Nauk im. V. I. Lenina *(U.S.S.R.)*

Drevo
Drevo *(Czechoslovakia)*

Drev. Vysk.
Drevarsky Vyskum *(Czechoslovakia)*

Earth Sci. (Tokyo)
Earth Science (Tokyo)
see Chikyu Kagaku

Earth-Sci. Rev.
Earth-Science Reviews *(Netherlands)*

Eau
Eau, L' *(France)*

Eiyo To Shokuryo
* Eiyo To Shokuryo (Journal of Japanese Society of Food and Nutrition) *(Japan)*

Ekon. Samf. Tidskr.
Ekonomiska Samfundets Tidskrift *(Sweden)*

Electron. Equip. News
Electronic Equipment News *(England)*

Electron. Ind. (Paris).
Electronique Industrielle (Paris) *(France)*

Electron. Packag. Prod.
Electronic Packaging and Production *(U. S.)*

Electrotech. J. Jap.
*Electrotechnical Journal of Japan *(Japan)*

Electrotechniek
Electrotechniek *(Netherlands)*

Elec. World
Electrical World *(U. S.)*

Elec. World (Shanghai)
Electrical World (Shanghai)
see Tien Shih Chieh

Elektrizitaetsverwertung
Elektrizitaetsverwertung *(Switzerland)*

Elektromedizin
Elektromedizin und Ihre Grezgebiete *(Germany)*

Elektron. Bol'shikh Moshch.
Elektronika Bol'shikh Moshchnostei *(U.S.S.R.)*

Elektron. Obrab. Mater.
Elektronnaya Obrabotka Materialov *(Moldavian S.S.R.)*

Elektron. Rechenanlagen
Elektronische Rechenanlagen *(West Germany)*

Elektrotech. Cas.
Elektrotechnicky Casopis *(Czechoslovakia)*

Elektrotekhnika
Elektrotekhnika *(U.S.S.R.)*

Elektr. Sta.
Elektricheskie Stantsii *(U.S.S.R.)*

Energetika
*Energetika *(Czechoslovakia)*

Engei Gakkai Zasshi
*Engei Gakkai Zasshi (Journal of the Japanese Society for Horticultural Science) *(Japan)*

Eng. Fracture Mech.
*Engineering Fracture Mechanics *(U. S.)*

Engl. Elec. J.
English Electric Journal *(England)*
Eng. Technol. (Osaka)
Engineering and Technology (Osaka)
see Kogaku To Gijutu
Entretiens Bichat, Stomatol.
Entretiens Bichat, Stomatologie *(France)*
Entropie
Entropie *(France)*
Environ. Health
Environmental Health *(India)*
Environ. Res.
Environmental Research *(U. S.)*
EPE, Rev. Energ. Primaire
EPE, Revue Energie Primaire
see Rev. Energ. Primaire
Ergonomics
Ergonomics *(England)*
Euphytica
Euphytica *(Netherlands)*
Euratom Rev.
*Euratom Review of the European Atomic Energy Community (formerly Euratom Bulletin) *(Belgium)*
Exp. Pathol.
Experimentelle Pathologie *(East Germany)*
Farm, Ranch, Home Quart.
Farm, Ranch and Home Quarterly *(U. S.)*
FDA (Food Drug Admin.) Pap.
FDA (Food and Drug Administration) Papers *(U. S.)*
Fette-Seifen-Anstrichm.
Fette-Seifen-Anstrichmittel (combined with Ernaehrungs-industrie) *(West Germany)*
Fish. Ind. Res.
*Fishery Industrial Research *(U. S.)*
Fiz. Chastits Vys. Energ., Akad. Nauk Gruz. SSSR, Inst. Fiz.
Fizika Chastits Vysokikh Energii, Akademiya Nauk Gruzinskoi SSR, Institut Fiziki *(Georgian S.S.R.)*
Fizika (Zagreb)
*Fizika (Zagreb) *(Yugoslavia)*
Fiziol. Norm. Patol. (Bucharest)
Fiziologia Normala si Patologica (Bucharest) *(Romania)*
Fiz. Khim. Obrab. Mater.
Fizika i Khimiya Obrabotki Materialov *(U.S.S.R.)*
Fiz.-Mat. Spis., Bulg. Akad. Nauk.
Fiziko Matematicheska Spisanie, Bulgarska Akademiya na Naukite, Fizicheski Institut, Matematicheski Institut *(Bulgaria)*
Fiz. Tekh. Poluprov.
*Fizika i Tekhnika Poluprovodnikov *(U.S.S.R.)*
Flame Notes, Beckman
Flame Notes, Beckman *(U. S.)*
Flug-Rev. Int.
Flug-Revue International *(West Germany)*
FOA (Forsvarets Forsk.) Rep.
*FOA (Forsvarets Forskningsanstalt) Reports *(Sweden)*
Folia Haematol. (Leipzig)
Folia Haematologia (Leipzig) *(East Germany)*
Folia Med. Cracov.
Folia Medica Cracoviensia *(Poland)*
Folia Pharm. Jap.
Folia Pharmacologica Japonica
see Nippon Yakurigaku Zasshi
Food Eng. (Philadelphia)
Food Engineering (Philadelphia) (formerly Food Industries) *(U. S.)*
Food Mfr.
Food Manufacture *(England)*
Forest. Abstr.
Forestry Abstracts *(England)*
Forsch. Ingenieurw.
Forschung im Ingenieurwesen *(West Germany)*
Fortschr. Hochpolym.-Forsch.
Fortschritte der Hochpolymeren-Forschung *(West Germany)*
Fortschr. Wasserchem. Ihrer Grenzgeb.
Fortschritte der Wasserchemie und Ihrer Grenzgebiete *(East Germany)*
Fortschr. Zool.
Fortschritte de Zoologie *(West Germany)*
Foundry
Foundry *(U. S.)*
Freiberg. Forschungsh., B
Freiberger Forschungshefte, Reihe B *(East Germany)*
Fuji Shashin Fuirumu Kenkyu Hokoku
*Fuji Shashin Fuirumu Kenkyu Hokoku (Scientific Publications of the Fuji Photo Film Co., Ltd.) *(Japan)*
Fukuoka Acta Med.
Fukuoka Acta Medica
see Fukuoka Igaku Zasshi
Fukuoka Igaku Zasshi
*Fukuoka Igaku Zasshi (Fukuoka Acta Medica) *(Japan)*
Fukushima Daigaku Gakugei Gakubu Rika Hokoku
Fukushima Daigaku Gakugei Gakubu Rika Hokoku (The Science Reports of the Faculty of Arts and Science, Fukushima University) *(Japan)*
Fune No Kagaku
Fune No Kagaku (Marine Engineering) *(Japan)*
G.E.C.-A.E.I. J. Sci. Technol.
G.E.C.-A.E.I. Journal of Science and Technology *(England)*
Genet. Pol.
*Genetica Polonica *(Poland)*
Genet. Sinica (Peking)
Genetica Sinica (Peking)
see I Ch'uan Hsueh Chi K'an
Genshiryoku Shiryo
Genshiryoku Shiryo (Atomic Energy Bulletin) *(Japan)*
Geofiz. App.
Geofizicheskaya Apparatura *(U.S.S.R.)*
Geofiz. Byull.
Geofizicheskii Byulleten *(U.S.S.R.)*
Geofys. Sb.
Geofysikalni Sbornik *(Czechoslovakia)*
Geol. Geofiz.
Geologiya i Geofizika *(U.S.S.R.)*
Geol. Mag.
Geological Magazine *(England)*
Geol. Nefti Gazo
Geologiya Nefti i Gaza† *(U.S.S.R.)*
Geol. Soc. Amer., Spec. Pap.
Geological Society of America, Special Paper *(U. S.)*
Geophys. Geol. (Leipzig)
Geophysik und Geologie (Leipzig) *(East Germany)*
Gidroaeromekhanika
Gidroaeromekhanika *(Ukrainian S.S.R.)*
Gidrokhim. Mater.
Gidrokhimicheskie Materialy *(U.S.S.R.)*
Giesserei
Giesserei *(West Germany)*
Gifu Ika Daigaku Kiyo
*Gifu Ika Daigaku Kiyo (Acta Scholae Medicinalis in Gifu) *(Japan)*
G-I-T (Glas- Instrum.-Tech.) Fachz. Lab.
G-I-T (Glas- und Instrumenten-Technik) Fachzietschrift fuer das Laboratorium *(West Germany)*
Glas-Instrum.-Tech.
Glas-Instrumenten-Technik *(West Germany)*
Glass Ceram. (USSR) (Engl. Transl.)
Glass and Ceramics (USSR) (English Translation of Steklo i Keramika) *(U. S.)*
Gorn. Zh.
Gornyi Zhurnal *(U.S.S.R.)*
Great Basin Natur.
Great Basin Naturalist *(U. S.)*
Grinding Finish.
Grinding and Finishing *(U. S.)*
Gueisuanyan Xuebao
Gueisuanyan Xuebao
see Kuei Suan Yen Hsueh Pao
Gunma Symp. Endocrinol.
Gunma Symposia on Endocrinology *(Japan)*
GWF (Gas Wasserfach)
GWF (Das Gas- und Wasserfach) *(West Germany)*
Haematologia (Budapest)
Haematologia (Budapest) *(Hungary)*
Haikan Gijutsu
*Haikan Gijutsu (The Piping Engineering) *(Japan)*
Hakko To Taisha
*Hakko To Taisha (Amino Acid and Nucleic Acid) *(Japan)*
Handb. Med. Radiol.
Handbuch der Medizinschen Radiologie *(West Germany)*
Harper Hosp. Bull.
Harper Hospital Bulletin *(U. S.)*
Hawaii Farm Sci.
Hawaii Farm Science *(U. S.)*
Health Lab. Sci.
Health Laboratory Science *(U. S.)*
Heidelberg. Akad. Wiss. Math.-Naturwiss. Kl., Sitzungsber.
Heidelberger Akademie der Wissenschaften. Mathematisch-Naturwissenschaftliche Klasse, Sitzungsberichte *(West Germany)*
Hemel Dampkring
Hemel en Dampkring *(Belgium)*
Hifuka Kiyo

*Hifuka Kiyo (Acta Dermatologica) *(Japan)*
High Pressure (Tokyo)
High Pressure (Tokyo)
see ***Koatsuryoku***
Hinyokika Kiyo
*Hinyokika Kiyo (Acta Urologica Japonica) *(Japan)*
Hirosaki Daigaku Nogakubu Gakujutsu Hokoku
Hirosaki Daigaku Nogakubu Gakujutsu Hokoku (Bulletin of the Faculty of Agriculture, Hirosaki University) *(Japan)*
Hiroshima Daigaku Kogakubu Kenkyu Hokoku
*Hiroshima Daigaku Kogakubu Kenkyu Hokoku (Bulletin of the Faculty of Engineering, Hiroshima University) *(Japan)*
Hiroshima Ken Eisei Kenkyushoho
*Hiroshima Ken Eisei Kenkyushoho (Annual Report of the Laboratory of Public Health, Hiroshima Prefecture) *(Japan)*
Hodowla Rosl., Aklim. Nasien.
Hodowla Roslin, Aklimatyzacja i Nasiennictwo *(Poland)*
Hoken Butsuri
*Hoken Butsuri (Journal of Japan Health Physics Society) *(Japan)*
Hokkaidoritsu Eisei Kenkyushoho
*Hokkaidoritsu Eisei Kenkyushoho (Report of the Hokkaido Inst. of Public Health) *(Japan)*
Hokuno
Hokuno (Agriculture in Hokkaido) *(Japan)*
Honvedorvos
Honvedorvos *(Hungary)*
Humangenetik
Humangenetik *(West Germany)*
Hyg. Sanit. (USSR) (Engl. Transl.)
Hygiene and Sanitation (USSR) (English Translation of Gigiena i Sanitariya) *(U. S.)*
Hyogo Noka Daigaku Kiyo
*Hyogo Noka Daigaku Kiyo (Memoirs of the Hyogo University of Agriculture) *(Japan)*
I Ch'uan Hsueh Chi K'an
I Ch'uan Hsueh Chi K'an (Genetica Sinica) *(China)*
Idengaku Zasshi, Suppl.
Idengaku Zasshi, Supplement (Japanese Journal of Genetics, Supplement) *(Japan)*
IEEE (Inst. Elec. Electron. Eng.) Trans. Audio Electroacoust.
*IEEE (Institute of Electrical and Electronics Engineers) Transactions on Audio and Electroacoustics *(U.S.)*
Ig. Sanita Pubblica
Igiene e Sanita Pubblica *(Italy)*
Ind. Aliment. Agr. (Paris)
Industries Alimentaires et Agricoles (Paris) *(France)*
Ind.-Anz.
Industrie-Anzeiger *(West Germany)*
Ind.-Elektron. Forsch. Fertigung
Industrie-Elektronik in Forschung und Fertigung *(West Germany)*
Index Litt. Nucl. Fr.
*Index de la Litterature Nucleaire Francaise *(France)*
Indian Farming
Indian Farming *(India)*
Indian Food Packer
Indian Food Packer *(India)*
Indian J. Agr. Sci.
Indian Journal of Agricultural Science, The *(India)*
Indian J. Appl. Chem.
Indian Journal of Applied Chemistry *(India)*
Indian J. Cancer
Indian Journal of Cancer *(India)*
Indian J. Occup. Health
Indian Journal of Occupational Health *(India)*
Indian J. Pathol. Bacteriol.
Indian Journal of Pathology and Bacteriology *(India)*
Indian Pediat.
Indian Pediatrics *(India)*
Indian Potato J.
Indian Potato Journal *(India)*
Ind. Mineraria
Industria Mineraria *(Italy)*
Ind. Process Heat.
Industrial and Process Heating *(England)*
Ins. Sci. Technol.
Industrial Science and Technology
see ***Kogyo Gijutsu***
Ind. Water Eng.
Industrial Water Engineering *(U. S.)*
Inform. Byull. Sov. Antarkt. Eksped.
Informatsionnyi Byulleten Sovetskoi Antarkticheskoi Ekspeditsii *(U.S.S.R.)*
Ing. Bygningsv., Ugeovers.
Ingenieor- og Bygningsvaesen, Ugeoversigt *(Denmark)*

Inorg. Chim. Acta
Inorganica Chimica Acta *(Italy)*
Inst. Mining Met., Trans./Sect. B
Institution of Mining and Metallurgy, Transactions/Section B. Applied Earth Science (continues in part Transactions of the Institution of Mining and Metallurgy) *(England)*
Inst. Petrol. Rev.
Institute of Petroleum Review, The *(England)*
Instrum. Contr. Eng.
Instrument and Control Engineering *(England)*
Instrum. Med.
Instrumentation in Medicine *(England)*
Int. Ass. Sci. Hydrol., Bull.
International Association of Scientific Hydrology, Bulletin *(Belgium)*
Int. Chem. Eng.
*International Chemical Engineering. A Quarterly Journal of Translations from Russia, Eastern Europe, and Asia *(U. S.)*
Int. Dig. Health Legislation
International Digest of Health Legislation *(Switzerland)*
Int. J. Mass Spectrom. Ion Phys.
International Journal of Mass Spectrometry and Ion Physics
see ***J. Mass Spectrom. Ion Phys.***
Int. J. Neurol.
International Journal of Neurology *(U. S.)*
Int. J. Theor. Phys.
*International Journal of Theoretical Physics *(England)*
Int. Rev. Gesam. Hydrobiol.
Internationale Revue der Gesamten Hydrobiologie *(East Germany)*
Int. Surg.
International Surgery *(U. S.)*
Inzh. Zh., Mekh. Tverd. Tela
Inzhenernyi Zhurnal, Mekhanika Tverdogo Tela (formerly Inzhenernyi Zhurnal) *(U.S.S.R.)*
Iron Age Metalwork. Int.
Iron Age Metalworking International *(U. S.)*
ISA (Instrum. Soc. Amer.), Proc., Nat. Power Instrum. Symp.
ISA (Instrument Society of America), Proceedings, National Power Instrumentation Symposium *(U. S.)*
Issled. Genet.
Issledovaniya po Genetike *(U.S.S.R.)*
Issled. Primen. Tsifrovykh Analogovykh Vychisl. Mash. Yad. Fiz. Tekh., Sb. Statei (U.S.S.R.)
*Issledovanie Primenenii Tsifrovykh i Analogovykh Vychislitel'nykh Mashin v Yadernoi Fizike i Tekhnike, Moskovskii Inzhenerno-Fizicheskii Institut, Sbornik Statei *(U.S.S.R.)*
Iwate Daigaku Kogakubu Kenkyu Hokoku
*Iwate Daigaku Kogakubu Kenkyu Hokoku (Report on Technology of Iwate University) *(Japan)*
Izobret., Prom. Obraztsy, Tovarnye Znaki
Izobreteniya, Promyshlennye Obraztsy, Tovarnye Znaki *(U.S.S.R.)*
Izv. Akad. Nauk Arm. SSR, Biol. Nauki
Izvestiya Akademii Nauk Armyanskoi SSR, Biologicheskie Nauki (superseded by Biologicheskii Zhurnal Armenii) *(Armenian S.S.R.)*
Izv. Akad. Nauk Arm. SSR, Khim. Nauki
Izvestiya Akademii Nauk Armyanskoi SSR, Khimicheskie Nauki *(Armenian S.S.R.)*
Izv. Akad. Nauk Arm. SSR, Ser. Fiz.-Mat. Nauk
Izvestiya Akademii Nauk Armyanskoi SSR, Seriya Fiziko-Matematicheskikh Nauk *(Armenian S.S.R.)*
Izv. Akad. Nauk Arm. SSR, Ser. Tekh. Nauk
Izvestiya Akademii Nauk Armyanskoi SSR, Seriya Tekhnicheskikh Nauk *(Armenian S.S.R.)*
Izv. Akad. Nauk Kaz. SSR, Ser. Khim.
Izvestiya Akademii Nauk Kazakhskoi SSR, Seriya Khimicheskaya *(Kazakh S.S.R.)*
Izv. Akad. Nauk SSSR, Otd. Tekh. Nauk, Mekh. Mashinostr.
Izvestiya Akademii Nauk SSSR, Otdelenie Tekhnicheskikh Nauk, Mekhanika i Mashinostroenie *(U.S.S.R.)*
Izv. Akad. Nauk SSSR, Ser. Biol.
Izvestiya Akademii Nauk SSSR, Seriya Biologicheskaya *(U.S.S.R.)*
Izv. Akad. Nauk SSSR, Ser. Geol.
Izvestiya Akademii Nauk SSSR, Seriya Geologicheskaya *(U.S.S.R.)*
Izv. Akad. Nauk SSSR, Ser. Mat.
Izvestiya Akademii Nauk SSSR, Seriya Matematicheskaya *(U.S.S.R.)*
Izv. Akad. Nauk Tadzh. SSR, Otd. Fiz.-Tekh. Khim. Nauk
Izvestiya Akademii Nauk Tadzhikskoi SSR, Otdelenie Fiziko-Tekhnicheskikh i Khimicheskikh Nauk *(Tadzhik S.S.R.)*
Izv. Akad. Nauk Uzb. SSR, Ser. Tekh. Nauk

Izvestiya Akademii Nauk Uzbekskoi SSR, Seriya Tekhnicheskikh Nauk *(Uzbek S.S.R.)*

Izv. Gl. Astron. Observ. Pulkove
Izvestiya Glavnoi Astronomicheskoi Observatorii v Pulkove *(U.S.S.R.)*

Izv. Inst. Elektron., Bulg. Akad. Nauk.
Izvestiya na Instituta po Elektronika, Bulgarska Akademiya na Naukite *(Bulgaria)*

Izv. Inst. Khidrol. Meteorol., Bulg. Akad. Nauk.
Izvestiya na Institutapo Khidrologiya i Meteorologiya, Bulgarska Akademiya na Naukite, Otdelenie za Matematicheski i Fizicheski Nauki *(Bulgaria)*

Izv. Timiryazev. Sel'skokhoz. Akad.
Izvestiya Timiryazevskoi Sel'skokhozyaistvennoi Akademii *(U.S.S.R.)*

Izv. Vost. Filial. Akad. Nauk SSSR
Izvestiya Vostochniykh Filialov Akademii Nauk SSSR *(U.S.S.R.)*

Izv. Vyssh. Uchob. Zaved., Mat.
*Izvestiya Vysshikh Uchebnykh Zavedenii, Matematika *(U.S.S.R.)*

Izv. Vyssh. Uchob. Zaved., Priborostr.
Izvestiya Vysshikh Uchebnykh Zavedenii, Priborostroenie *(U.S.S.R.)*

Izv. Vyssh. Uchob. Zaved., Tekhnol. Legk. Prom.
Izvestiya Vysshikh Uchebnykh Zavedenii, Tekhnologiya Legkoi Promyshlennosti *(Ukrainian S.S.R.)*

J. Amer. Podiat. Ass.
Journal of the American Podiatry Association *(U. S.)*

J. Amer. Soc. Safety Eng.
Journal of the American Society of Safety Engineers *(U. S.)*

J. Annamalai Univ., Part B
Journal of the Annamalai University, Part B *(India)*

Jap. J. Anesthesiol.
Japanese Journal of Anesthesiology, The
see Masui

Jap. J. Dairy Sci.
Japanese Journal of Dairy Science (Japan)
see Rakuno Kagaku no Kenkyu

Jap. J. Exp. Morphol.
Japanese Journal of Experimental Morphology
see Jikken Kaitaigakushi

Jap. J. Genet., Suppl.
Japanese Journal of Genetics, Supplement
see Idengaku Zasshi, Suppl.

Jap. J. Hum. Genet.
Japanese Journal of Human Genetics, The
see Jinrui Idengaku Zasshi

Jap. J. Ind. Health
Japanese Journal of Industrial Health
see Sangyo Igaku

Jap. J. Ophthalmol.
Japanese Journal of Ophthalmology *(Japan)*

Jap. J. Pharm. Chem.
Japanese Journal of Pharmacy and Chemistry
see Yakugaku Kenkyu

Jap. J. Urol.
Japanese Journal of Urology, The
see Nippon Hinyokika Gakkai Zasshi

Jap. J. Zootech. Sci.
Japanese Journal of Zootechnical Science
see Nippon Chikusangaku Kaiho

JARE Sci. Rep., Spec. Issue
JARE Scientific Reports, Special Issue *(Japan)*

J. Ass. Phys. Ment. Rehabil.
Journal of the Association for Physical and Mental Rehabilitation *(U. S.)*

J. Ass. Public Anal.
Journal of the Association of Public Analysts *(England)*

J. Aust. Ceram. Soc.
Journal of the Australian Ceramic Society *(Australia)*

J. Balneol. Soc. Jap.
Journal of the Balneological Society of Japan
see Onsen Kagaku

J. Belge Radiol., Monogr.
*Journal Belge de Radiologie, Monographie *(Belgium)*

J. Biol. Photogr. Ass.
Journal of the Biological Photographic Association, The *(U. S.)*

J. Brit. Ceram. Soc.
Journal of the British Ceramic Society, The *(England)*

J. Cell Sci.
*Journal of Cell Science *(England)*

J. Chiba Med. Soc.
Journal of Chiba Medical Society, The
see Chiba Igakkai Zasshi

J. Chin. Silicates Soc.
Journal of the Chinese Silicates Society
see Kuei Suan Yen Hsueh Pao

J. Comb. Theory
Journal of Combinatorial Theory *(U. S.-England)*

J. Cons. Perma. Int. Explor. Mer
Journal du Conseil, Conseil Permanent International pour l'Exploration de la Mer *(Denmark)*

J. Cryst. Growth
Journal of Crystal Growth *(Netherlands)*

J. Curr. Laser Abstr.
Journal of Current Laser Abstracts *(Canada)*

J. Earth Sci., Nagoya Univ.
*Journal of Earth Sciences, Nagoya University, The *(Japan)*

J. Ecol.
Journal of Ecology *(England)*

J. Egypt. Public Health Ass.
Journal of the Egyptian Public Health Association *(Egypt)*

Jemna Mech. Opt.
Jemna Mechanika a Optika *(Czechoslovakia)*

Jeune Sci.
Jeune Scientifique *(Canada)*

J. Food Hyg. Soc. Jap.
Journal of the Food Hygienic Society of Japan
see Shokuhin Eiseigaku Zasshi

J. Food Sci. Technol.
Journal of Food Science and Technology
see Nippon Shokuhin Kogyo Gakkaishi

J. Forensic Med.
Journal of Forensic Medicine *(South Africa)*

J. Formosan Med. Ass.
Journal of the Formosan Medical Association
see T'ai-wan I Hsueh Hui Tsa Chih

J. Fr. Oto-Rhino-Laryngol.
Journal Francais d'Oto-Rhino-Laryngologie et Chirurgie Maxillo-Faciale *(France)*

J. Fuel Heat. Technol.
Journal of Fuel and Heating Technology *(England)*

J. Geol.
Journal of Geology *(U. S.)*

J. High Polym. (Shanghai)
Journal of High Polymers (Shanghai)
see Kao Fen Tzu T'ung Hsun

Jibiinkoka Rinsho
*Jibiinkoka Rinsho (Oto-Rhino-Laryngological Clinic) *(Japan)*

Jikken Kaitaigakushi
Jikken Kaitaigakushi (Japanese Journal of Experimental Morphology) *(Japan)*

J. Indian Soc. Soil Sci.
Journal of the Indian Society of Soil Science *(India)*

Jinrui Idengaku Zasshi
Jinrui Idengaku Zasshi (The Japanese Journal of Human Genetics) *(Japan)*

J. Inst. Safety High Pressure Gas Eng.
Journal of the Inst. of Safety of High Pressure Gas Engineering
see Koatsu Gasu

J. Inst. Telecommun. Eng.
Journal of the Institution of Telecommunication Engineers *(India)*

J. Irish Med. Ass.
Journal of the Irish Medical Association *(Ireland)*

J. Irrig. Drain. Div., Amer. Soc. Civil Eng.
Journal of the Irrigation and Drainage Division, Proceedings of the American Society of Civil Engineers *(U. S.)*

J. Jap. Ass. Phys. Med., Balneol., Climatol.
Journal of the Japanese Association of Physical Medicine, Balneology, and Climatology, The
see Nippon Onsen Kiko Butsuri Igakkai Zasshi

J. Jap. Health Phys. Soc.
Journal of Japan Health Physics Society
see Hoken Butsuri

J. Jap. Med. Ass.
Journal of the Japan Medical Association, The
see Nippon Ishikai Zasshi

J. Jap. Petrol. Inst.
Journal of the Japan Petroleum Institute
see Sekiyu Gakkaishi

J. Jap. Soc. Food Nutr.
Journal of Japanese Society of Food and Nutrition
see Eiyo To Shokuryo

J. Jap. Soc. Hort. Sci.
Journal of the Japanese Society for Horticultural Science
see Engei Gakkai Zasshi

J. Jap. Stomatol. Soc.
Journal of the Japan Stomatological Society, The
see Kokubyo Gakkai Zasshi

J. Jap. Tech. Ass. Pulp Pap. Ind.
Journal of the Japanese Technical Association of Pulp and Paper Industry
see Kami Pa Gikyoshi

J. Jap. Wood Res. Soc.
Journal of the Japan Wood Research Society
see Mokuzai Gakkaishi

J. Karnatak Univ.
Journal of the Karnatak University *(India)*

J. Kyoto Prefect. Med. Univ.
Journal of Kyoto Prefectural Medical University
see Kyoto Furitsu Ika Daigaku Zasshi

J. Macromol. Sci., Part A
Journal of Macromolecular Science, Part A. Chemistry (supersedes Journal of Macromolecular Chemistry) *(U. S.)*

J. Maine Med. Ass.
Journal of the Maine Medical Association *(U. S.)*

J. Marine Res.
Journal of Marine Research (Sears Foundation for Marine Research) *(U.S.)*

J. Mass Spectrom. Ion Phys.
*Journal of Mass Spectrometry and Ion Physics *(Netherlands)*

J. Med. Soc. N. J.
Journal of the Medical Society of New Jersey *(U. S.)*

J. Metal Finish. Soc. Jap.
Journal of the Metal Finishing Society of Japan, The
see Kinzoku Hyomen Gijutsu

J. Mines, Metals Fuels
Journal of Mines, Metals and Fuels *(India)*

J. Miss. State Med. Ass.
Journal of the Mississippi State Medical Association *(U. S.)*

J. Mol. Struct.
*Journal of Molecular Structure *(Netherlands)*

J. Nagasaki Med. Ass., Suppl.
Journal of the Nagasaki Medical Association, Supplement
see Nagasaki Igakkai Zasshi, Suppl.

J. Neurol. Sci.
Journal of the Neurological Sciences *(Netherlands)*

J. Nucl. Med., Suppl.
*Journal of Nuclear Medicine, Supplement *(U.S.)*

J. Nucl. Sci. (Seoul)
*Journal of Nuclear Sciences (Seoul) (Wonjaryogwon. Yon'gu Nonmun Chip) *(South Korea)*

J. Obstet. Gynaecol. India
Journal of Obstetrics and Gynaecology of India *(India)*

J. Optimization Theory Appl.
Journal of Optimization Theory and Applications *(U. S.)*

J. Oral Surg.
Journal of Oral Surgery *(U. S.)*

J. Osaka Univ. Dent. Soc.
Journal of the Osaka University Dental Society, The
see Osaka Daigaku Shigaku Zasshi

J. Otolaryngol. Soc. Aust.
Journal of the Otolaryngological Society of Australia *(Australia)*

J. Paleontol.
Journal of Paleontology *(U.S.)*

J. Phys., A (London)
*Journal of Physics, A (London), Proceedings of the Physical Society (General) (supersedes in part Proceedings of the Physical Society (London)) *(England)*

J. Phys., B (London)
*Journal of Physics, B (London), Proceedings of the Physical Society (Atomic and Molecular Physics) (supersedes in part Proceedings of the Physical Society (London)) *(England)*

J. Phys., C (London)
*Journal of Physics, C (London), Proceedings of the Physical Society (Solid State Physics) (supersedes in part Proceedings of the Physical Society (London)) *(England)*

J. Phys., E (London)
*Journal of Physics, E (London) (supersedes Journal of Scientific Instruments) *(England)*

J. Phys. Chem. Solids, Suppl.
*Journal of Physics and Chemistry of Solids, Supplement *(England)*

J. Physiol. Soc. Jap.
Journal of the Physiological Society of Japan
see Nippon Seirigaku Zasshi

J. Phys. Soc. Jap., Suppl.
*Journal of the Physical Society of Japan, Supplement *(Japan)*

J. Proc. Inst. Chem. (India)
Journal and Proceedings of the Institution of Chemists (India) *(India)*

J. Radioanal. Chem.
*Journal of Radioanalytical Chemistry *(Netherlands–Hungary)*

J. Radiol. Phys. Ther., Univ. Kanazawa
Journal of Radiology and Physical Therapy, University of Kanazawa, The
see Kanazawa Irigaku Sosho

J. Roy. Army Med. Corps
Journal of the Royal Army Medical Corps *(England)*

J. Sapporo Munic. Gen. Hosp.
Journal of Sapporo Municipal General Hospital, The
see Shiritsu Sapporo Byoin Ishi

J. Sediment. Petrol.
Journal of Sedimentary Petrology *(U. S.)*

J. Sericult. Sci. Jap.
Journal of Sericultural Science of Japan, The
see Nippon Sanshigaku Zasshi

J. Soc. Eng. Miner. Springs, Jap.
Journal of the Society of Engineers for Mineral Springs, Japan
see Onsen Kogakkaishi

J. Soc. Fiber Sci. Technol., Jap.
Journal of the Society of Fiber Science and Technology, Japan
see Sen'i Gakkaishi

J. Soc. Instrum. Contr. Eng.
Journal of the Society of Instrument and Control Engineers
see Keisoku To Seigyo

J. Soc. Leather Trades Chem.
Journal of the Society of Leather Trades Chemists *(England)*

J. Soc. Precis. Mech. Jap.
Journal of the Society for Precision Mechanics of Japan
see Seimitsu Kikai

J. Soc. Rubber Ind., Jap.
Journal of the Society of Rubber Industry, Japan
see Nippon Gomu Kyokaishi

J. Soc. Sci. Photogr. Jap.
Journal of the Society of Scientific Photography of Japan, The
see Nippon Shashin Gakkai Kaishi

J. Tenn. Acad. Sci.
Journal of the Tennessee Academy of Science *(U. S.)*

J. Tenn. Med. Ass.
Journal of the Tennessee Medical Association *(U. S.)*

J. Tokyo Women's Med. Coll.
Journal of Tokyo Women's Medical College
see Tokyo Joshi Ika Daigaku Zasshi

Jugoslov. Pronalazastvo
Jugoslovensko Pronalazastvo *(Yugoslavia)*

J. Urol. Nephrol, Suppl.
Journal d'Urologie et de Nephrologie, Supplement *(France)*

Kagaku Keisatsu Kenkyusho Hokoku
*Kagaku Keisatsu Kenkyusho Hokoku (Reports of the National Research Inst. of Police Science) *(Japan)*

Kagaku Kogaku
*Kagaku Kogaku (Chemical Engineering, Japan) *(Japan)*

Kagaku Kojo
*Kagaku Kojo (Chemical Factory) *(Japan)*

Kagoshima Daigaku Suisangakubu Kiyo
*Kagoshima Daigaku Suisangakubu Kiyo (Memoirs of the Faculty of Fisheries, Kagoshima University) *(Japan)*

Kaibogaku Zasshi
Kaibogaku Zasshi (Acta Anatomica Nipponica) *(Japan)*

Kali Steinsalz
Kali und Steinsalz *(West Germany)*

Kami Pa Gikyoshi
*Kami Pa Gikyoshi (Journal of the Japanese Technical Association of Pulp and Paper Industry) *(Japan)*

Kanazawa Daigaku Kekkaku Kenkyusho Nenpo
*Kanazawa Daigaku Kekkaku Kenkyusho Nenpo (Annual Report of the Research Inst. of Tuberculosis, Kanazawa University) *(Japan)*

Kanazawa Irigaku Sosho
Kanazawa Irigaku Sosho (Journal of Radiology and Physical Therapy, University of Kanazawa, The) *(Japan)*

Kao Fen Tzu T'ung Hsun
Kao Fen Tzu T'ung Hsun (Journal of High Polymers) *(China)*

Keisoku To Seigyo
Keisoku To Seigyo (Journal of the Society of Instrument and Control Engineers) *(Japan)*

Kenchiku Gijutsu
Kenchiku Gijutsu (Building Engineering) *(Japan)*

Kernenergie, Beil.
*Kernenergie, Beilage *(East Germany)*

Kinzoku Hyomen Gijutsu
*Kinzoku Hyomen Gijutsu (The Journal of the Metal Finishing Society of Japan) *(Japan)*

Kitakanto Igaku
*Kitakanto Igaku (Kitakanto Medical Journal) *(Japan)*

Kitakanto Med. J.
Kitakanto Medical Journal
see Kitakanto Igaku

Kleinheubacher Ber.

Kleinheubacher Berichte *(East Germany)*

Klepzig Fachber.
Klepzig Fachberichte fuer die Fuehrungskraefte aus Maschinenbau und Huettenwesen (formerly Klepzigs Anzeiger fuer die Berg-, Huetten-, Metall- und Maschinenindustrie) *(West Germany)*

Klin. Med. (Moscow)
Klinicheskaya Meditsina (Moscow) *(U.S.S.R.)*

Klin. Monatsbl. Augenheilk.
Klinische Monatsblaetter fuer Augenheilkunde und fuer Augenaerztliche Fortbildung *(West Germany)*

Klin. Oczna
Klinika Oczna *(Poland)*

Koatsu Gasu
*Koatsu Gasu (Journal of the Inst. of Safety of High Pressure Gas Engineering) *(Japan)*

Koatsuryoku
Koatsuryoku (High Pressure) *(Japan)*

Kobe Kogyo Giho
*Kobe Kogyo Giho (Kobe Kogyo Technical Report) *(Japan)*

Kobe Kogyo Tech. Rep.
Kobe Kogyo Technical Report
see Kobe Kogyo Giho

Kobunshi Kako
Kobunshi Kako (Polymer Application) *(Japan)*

Kogaku To Gijutu
Kogaku To Gijutu (Engineering and Technology) *(Japan)*

Kogyo Gijutsu
Kogyo Gijutsu (Industrial Science and Technology) *(Japan)*

K'o Hsueh To Chung
K'o Hsueh To Chung (Popular Science) *(China)*

Kokubyo Gakkai Zasshi
Kokubyo Gakkai Zasshi (Journal of the Japan Stomatological Society, The) *(Japan)*

Konkurito Janaru
Konkurito Janaru (Concrete Journal) *(Japan)*

Konserv. Ovoshchesush. Prom.
Konservnaya i Ovoshchesushil'naya Promyshlennost *(U.S.S.R.)*

Konzerv- Paprikaipar
Konzerv- es Paprikaipar *(Hungary)*

Korroz. Metal. Splavov
Korroziya Metallov i Splavo *(U.S.S.R.)*

Kosm. Biol. Med.
Kosmicheskaya Biologiya i Meditsina *(U.S.S.R.)*

Kosm. Luchi
Kosmicheskie Luchi *(U.S.S.R.)*

Kovove Mater.
Kovove Materialy *(Czechoslovakia)*

Kowan Giken Shiryo
*Kowan Giken Shiryo (Technical Note of Port and Harbour Technical Research Inst., Ministry of Transportation, Japan) *(Japan)*

Krist. Tech.
Kritstall und Technik *(East Germany)*

Ktavim
Ktavim *(Israel)*

Kuei Suan Yen Hsueh Pao
Kuei Suan Yen Hsueh Pao (Journal of the Chinese Silicates Society) *(China)*

Kuki Seijo
*Kuki Seijo (Air Cleaning) *(Japan)*

Kumamoto Daigaku Kogakubu Kenkyu Hokoku
*Kumamoto Daigaku Kogakubu Kenkyu Hokoku (Technical Reports of the Kumamoto University) *(Japan)*

Kumamoto Daigaku Kyoikugakubu Kiyo
*Kumamoto Daigaku Kyoikugakubu Kiyo (Memoirs of the Faculty of Education, Kumamoto University) *(Japan)*

Kurznachr. Akad. Wiss. Goettingen
Kurznachrichten der Akademie der Wissenschaften in Goettingen *(West Germany)*

Kyosai Iho
*Kyosai Iho (Medical Journal of Mutual Aid Association) *(Japan)*

Kyoto Daigaku Kogyo Kyoin Yoseijo Kenkyu Hokoku
*Kyoto Daigaku Kogyo Kyoin Yoseijo Kenkyu Hokoku (Report of the Training Inst. for Engineering Teachers, Kyoto University) *(Japan)*

Kyoto Furitsu Ika Daigaku Zasshi
*Kyoto Furitsu Ika Daigaku Zasshi (Journal of Kyoto Prefectural Medical University) *(Japan)*

Kyushu Daigaku Kogaku Shuho
*Kyushu Daigaku Kogaku Shuho (Technology Reports of the Kyushu University) *(Japan)*

Kyushu Daigaku Nogakubu Gakugei Zasshi
*Kyushu Daigaku Nogakubu Gakugei Zasshi (Science Bulletin of the Faculty of Agriculture, Kyushu University) *(Japan)*

Kyushu Daigaku Seisan Kagaku Kenkyusho Hokoku
*Kyushu Daigaku Seisan Kagaku Kenkyusho Hokoku (The Reports of the Research Inst. of Science and Industry, Kyushu University) *(Japan)*

Labdev (Kanpur)
Labdev (Kanpur) *(India)*

Lahey Clin. Found. Bull.
Lahey Clinic Foundation Bulletin (formerly Lahey Clinic Bulletin) *(U. S.)*

Lakokrasoch. Mater. Ikh Primen.
Lakokrasochnye Materialy i Ikh Primenenie *(U.S.S.R.)*

Lan Chou Ta Hsueh Hsueh Pao, Tzu Jan K'o Hsueh
Lan Chou Ta Hsueh Hsueh Pao, Tzu Jan K'o Hsueh (The Lanchow University Journal, The Natural Sciences) *(China)*

Lanchow Univ. J., Natur. Sci.
Lanchow University Journal, The, The Natural Sciences
see Lan Chou Ta Hsueh Hsueh Pao, Tzu Jan K'o Hsueh

Landarzt
Landarzt *(West Germany)*

Landbouwtijdschrift
Landbouwtijdschrift *(Belgium)*

Lasers Opt. Non Conv.
Lasers et Optique Non Conventionelle *(France)*

Lav. Med.
Lavoro e Medicina *(Italy)*

Lebensversicherungsmedizin
Lebensversicherungsmedizin *(West Germany)*

Light Metal Age
Light Metal Age *(U. S.)*

Light Metals
Light Metals (superseded by Light Metals and Metals Industry (London)) *(England)*

Light Metals Metal Ind. (London)
Light Metals and Metal Industry (London) (formed by merger of Light Metals and The Metal Industry (London)) *(England)*

Lipids
Lipids *(U. S.)*

Liteinoe Proizvod.
Liteinoe Proizvodstvo *(U.S.S.R.)*

Lithos
Lithos *(Norway)*

Lutte Cancer
Lutte Contre le Cancer *(France)*

Machinery (N. Y.)
Machinery (New York) *(U. S.)*

Mech. Prod. Eng.
Machinery and Production Engineering *(England)*

Mech. Shop Eng. Mfg.
Machine Shop and Engineering Manufacture *(England)*

Mech. Tool Blue Book
Machine and Tool Blue Book *(U. S.)*

Macromolecules
Macromolecules *(U. S.)*

Mag. Stand.
Magazine of Standards *(U. S.)*

Magy. Traumatol., Orthop. Helyreallito Sebesz.
Magyar Traumatologia, Orthopaedia es Helyreallito Sebeszet *(Hungary)*

Manage. Sci.
Management Science *(U.S.)*

Mar. Eng.
Marine Engineering
see Funo No Kogaku

Mashinovedenie
Mashinovedenie *(U.S.S.R.)*

Mass Prod.
Mass Production *(England)*

Masui
*Masui (The Japanese Journal of Anesthesiology) *(Japan)*

Mater. Res. Bull.
Materials Research Bulletin *(U. S.)*

Meas. Instrum. Rev.
Measurement and Instrument Review *(England)*

Mech. World Eng. Rec.
*Mechanical World and Engineering Record *(England)*

Med. Bull. U. S. Army, Eur.
Medical Bulletin of the U. S. Army, Europe *(U.S.)*

Mededel. Kon. Vlaam. Acad. Wetensch. Belg., Kl. Wetensch.
Mededelingen van de Koninklijke Vlaamse Academie voor Wetenschappen, Letteren on Schone Kunsten van Belgie, Klasse der Wetenschappen *(Belgium)*

Medicina (Buenos Aires)
Medicina (Buenos Aires) *(Argentina)*

Med. J. Mutual Aid Ass.

Medical Journal of Mutual Aid Association
see Kyosai Iho

Med.-Markt/Acta Medicotech.
Medizinal-Markt/Acta Medicotechnica *(Germany)*

Med. Nucl.-Radiobiol. Lat., Suppl.
*Medicina Nucleare–Radiobiologica Latina, Suppl. *(Italy)*

Med. Prom. SSSR
Meditsinskaya Promyshlennost SSSR *(U.S.S.R)*

Med. Radiol. (USSR) (Engl. Transl.)
Medical Radiology (USSR) (English Translation of Meditsinskaya Radiologiya) *(U. S.)*

Mekh. Elek. Sots. Sel. Khoz.
Mekhanizatsiya i Elektrifikatsiya Sotsialisticheskogo Sel'skogo Khozyaistva *(U.S.S.R.)*

Mekh. Polim.
Mekhanika Polimerov *(Latvian S.S.R.)*

Mekh. Razrusheniya Metal., Akad. Nauk Ukr. SSR, Respub. Mezhvedom. Sb.
Mekhanizm Razrusheniya Metallov, Akademiya Nauk Ukrainskoi SSR, Respublikanskii Mezhvedomstvennyi Sbornik *(Ukrainian S.S.R.)*

Mem. Fac. Educ., Kumamoto Univ.
Memoirs of the Faculty of Education, Kumamoto University
see Kumamoto Daigaku Kyoikugakubu Kiyo

Mem. Fac. Eng., Kyushu Univ.
*Memoirs of the Faculty of Engineering, Kyushu University *(Japan)*

Mem. Fac. Fish., Kagoshima Univ.
Memoirs of the Faculty of Fisheries, Kagoshima University
see Kagoshima Daigaku Suisangakubu Kiyo

Mem. Fac. Sci., Kyoto Univ., Ser. Biol.
*Memoirs of the Faculty of Science, Kyoto University, Series of Biology (formerly Memoirs of the College of Science, University of Kyoto, Series B (Biology)) *(Japan)*

Mem. Fac. Sci., Kyoto Univ., Ser. Phys., Astrophys., Geophys., Chem.
*Memoirs of the Faculty of Science, Kyoto University, Series of Physics, Astrophysics, Geophysics, and Chemistry (formerly Memoirs of the College of Science, University of Kyoto, Series A) *(Japan)*

Mem. Hyogo Univ. Agr.
Memoirs of the Hyogo University of Agriculture
see Hyogo Noka Daigaku Kiyo

Meres Automat.
Meres es Automatika *(Hungary)*

Mes., Regul., Automat.
Mesures, Regulation, Automatisme *(France)*

Messtechnik
*Messtechnik. Zeitschrift fuer Instrumentenkunde (supersedes Zeitschrift fuer Instrumentenkunde) *(West Germany)*

Mes.-Steuern-Regeln
Messen-Steuern-Regeln *(East Germany)*

Metabolism
*Metabolism: Clinical and Experimental *(U. S.)*

Metal Finish.
Metal Finishing *(U. S.)*

Metallwirtschaft
Metallwirtschaft–Wissenschaft–Technik *(Germany)*

Metals (London)
Metals (London) *(England)*

Metals Abstr.
*Metals Abstracts (successor to Review of Metal Literature and Metallurgical Abstracts) *(U. S.-England)*

Metal Sci. Heat Treat. (USSR) (Engl. Transl.)
Metal Science and Heat Treatment (USSR) (English Translation of Metallovedenie i Termicheskaya Obrabotka Metallov) *(U. S.)*

Metal Treat.
Metal Treating *(U. S.)*

Metalurgia (Sao Paulo)
Metalurgia (Sao Paulo) *(Brazil)*

Met. Elec. (Madrid)
Metalurgia y Electricidad (Madrid) *(Spain)*

Meteoritika
Meteoritika *(U.S.S.R.)*

Method. Phys. Anal.
Methodes Physiques d'Analyse *(France)*

Meth. Phys. Anal.
Methodes Physiques d'Analyse *(France)*

Met. Rev. (Publ. in Metals Mater.)
*Metallurgical Reviews (Published in Metals and Materials) *(England)*

Met. Spec. (Paris)
Metallurgie Speciale (Paris) *(France)*

Microwaves
Microwaves *(U. S.)*

Mie Daigaku Nogakubu Gakujutsu Hokoku
Mie Daigaku Nogakubu Gakujutsu Hokoku (The Bulletin of the Faculty of Agriculture, Mie University) *(Japan)*

Mie Kaibo Gyosekishu
Mie Kaibo Gyosekishu *(Japan)*

Milk Dealer
Milk Dealer, The *(U. S.)*

Miner. Deposita
Mineralium Deposita *(West Germany)*

Minerva Med. Giuliana
*Minerva Medica Giuliana. Supplemento a Minerva Medica *(Italy)*

Minerva Med. Sicil.
*Minerva Medica Siciliana (continuation of Gazzetta Medica Siciliana) Supplemento a Minerva Medica *(Italy)*

Minerva Med., Suppl.
*Minerva Medica, Supplemento *(Italy)*

Minerva Radiol.
*Minerva Radiologica (formerly Minerva Radiologica, Fisioterapica e Radiobiologica) *(Italy)*

Mines Met.
Mines et Metallurgie *(France)*

Mining Congr. J.
Mining Congress Journal *(U. S.)*

Mining Met. Quart. (USSR) (Engl. Transl.)
Mining and Metallurgy Quarterly (USSR) (English Translation of Rudarsko-Metalurski Zbornik) *(Yugoslavia)*

Mining Met. Quart. (USSR) (Engl. Transl.), Suppl.
Mining and Metallurgy Quarterly, (USSR) (English Translation of Rudarsko-Metalurski Zbornik, Supplement) *(Yugoslavia)*

Missili Spazio
Missili e Spazio *(Italy)*

Mod. Packag.
Modern Packaging *(U. S.)*

Mod. Unfallverhuet.
Moderne Unfallverhuetung *(West Germany)*

Mokuzai Gakkaishi
*Mokuzai Gakkaishi (Journal of the Japan Wood Research Society) *(Japan)*

Mol. Biol.
*Molekulyarnaya Biologiya *(U.S.S.R.)*

Molk.-Ztg. Welt Milch
Molkerei-Zeitung Welt der Milch *(West Germany)*

Mon. Corresp. Befoerd. Erd Himmelskunde
Monatliche Correspondenz zur Befoerderung der Erd und Himmelskunde *(East Germany)*

Monit. Zool. Ital., Suppl.
Monitore Zoologico Italiano, Supplemento *(Italy)*

Monogr. Nucl. Med. Biol.
Monographs on Nuclear Medicine and Biology *(Netherlands)*

Montes
Montes *(Spain)*

Motor Ship
Motor Ship *(England)*

Motortech. Z.
Motortechnische Zeitschrift *(West Germany)*

Muanyag Gumi
Muanyag es Gumi *(Hungary)*

Nachrichtentech. Fachber.
Nachrichtentechnische Fachberichte *(West Germany)*

Nachrichtentechnik
Nachrichtentechnik *(East Germany)*

Nagano Kogyo Koto Senmon Gakko Kiyo
Nagano Kogyo Koto Senmon Gakko Kiyo (Research Reports, Nagano Technical College) *(Japan)*

Nagasaki Igakkai Zasshi, Suppl.
Nagasaki Igakkai Zasshi, Supplement (Journal of the Nagasaki Medical Association, Supplement) *(Japan)*

Nan Ching Ta Hsueh Hsueh Pao, Tzu Jan K'o Hsueh
Nan Ching Ta Hsueh Hsueh Pao, Tzu Jan K'o Hsueh (Acta Universitatis Nankinensis Scientiarum Naturalium) *(China)*

Nat. Fire Codes
National Fire Codes *(U. S.)*

Nat. Med. J. China
National Medical Journal of China
see Chung Hua I Hsueh Tsa Chih

Natur. Appl. Sci. Bull.
Natural and Applied Science Bulletin *(Philippines)*

Nauch. Zap. Inst. Mashinoved. Avtomat., Akad. Nauk Ukr. SSR, Ser. Mashinoved.
Nauchnye Zapiski Instituta Mashinovedeniya i Avtomatiki, Akademiya Nauk Ukraninskoi SSR, Seriya Mashinovedeniya *(Ukrainian S.S.R.)*

Neftegazov. Geol. Geofiz.
Neftegazovaya Geologiya i Geofizika *(U.S.S.R.)*

Nerv. Sist., Leningrad. Gos. Univ., Fiziol. Inst.

Nervnaya Sistema, Leningradskii Gosudarstvennyi Universitet imeni A. A. Zhdanova, Fiziologicheskii Institut *(U.S.S.R.)*

Neth. J. Sea Res.
Netherlands Journal of Sea Research *(Netherlands)*

Neues Jahrb. Mineral., Monatsh.
Neues Jahrbuch fuer Mineralogie, Monatshefte *(West Germany)*

Neurol., Neurochir. Psychiat. Pol.
Neurologia, Neurochirurgia i Psychiatria Polska *(Poland)*

Newslett. Isotop. Generator Inform. Centre
*Newsletter of the Isotopic Generator Information Centre *(France)*

Nichidai Igaku Zasshi
*Nichidai Igaku Zasshi (Nihon University Medical Journal) *(Japan)*

Nichidai Shigaku
*Nichidai Shigaku (Nihon University Dental Journal) *(Japan)*

Nihon Univ. Dent. J.
Nihon University Dental Journal
see *Nichidai Shigaku*

Nihon Univ. J. Med.
*Nihon University Journal of Medicine, The *(Japan)*

Nihon Univ. Med. J.
Nihon University Medical Journal
see *Nichidai Igaku Zasshi*

Nippon Byori Gakkai Kaishi
Nippon Byori Gakkai Kaishi (Transactiones Societatis Pathologicae Japonicae) *(Japan)*

Nippon Chikusangaku Kaiho
Nippon Chikusangaku Kaiho (Japanese Journal of Zootechnical Science) *(Japan)*

Nippon Geka Hokan
Nippon Geka Hokan (Archiv fuer Japanische Chirurgie) *(Japan)*

Nippon Gomu Kyokaishi
*Nippon Gomu Kyokaishi (Journal of the Society of Rubber Industry, Japan) *(Japan)*

Nippon Hinyokika Gakkai Zasshi
Nippon Hinyokika Gakkai Zasshi (The Japanese Journal of Urology) *(Japan)*

Nippon Ishikai Zasshi
Nippon Ishikai Zasshi (The Journal of the Japan Medical Association) *(Japan)*

Nippon Kaisui Gakkaishi
Nippon Kaisui Gakkaishi (Bulletin of the Society of Sea Water Science, Japan) *(Japan)*

Nippon No Kagaku To Gijutsu
*Nippon No Kagaku To Gijutsu (Science and Technology of Japan) *(Japan)*

Nippon Onsen Kiko Butsuri Igakkai Zasshi
*Nippon Onsen Kiko Butsuri Igakkai Zasshi (The Journal of the Japanese Association of Physical Medicine, Balneology, and Climatology) *(Japan)*

Nippon Sakumotsu Gakkai Kiji
*Nippon Sakumotsu Gakkai Kiji (Proceedings of the Crop Science Society of Japan) *(Japan)*

Nippon Sanshigaku Zasshi
*Nippon Sanshigaku Zasshi (The Journal of Sericultural Science of Japan) *(Japan)*

Nippon Seirigaku Zasshi
*Nippon Seirigaku Zasshi (Journal of the Physiological Society of Japan) *(Japan)*

Nippon Shashin Gakkai Kaishi
*Nippon Shashin Gakkai Kaishi (The Journal of the Society of Scientific Photography of Japan) *(Japan)*

Nippon Shokubutsu Byori Gakkaiho
*Nippon Shokubutsu Byori Gakkaiho (Annals of the Phytopathological Society of Japan) *(Japan)*

Nippon Shokuhin Kogyo Gakkaishi
Nippon Shokuhin Kogyo Gakkaishi (Journal of Food Science and Technology) *(Japan)*

Nippon Shonika Gakkai Zasshi
*Nippon Shonika Gakkai Zasshi (Acta Paediatrica Japonica) *(Japan)*

Nippon Yakurigaku Zasshi
*Nippon Yakurigaku Zasshi (Folia Pharmacologica Japonica) *(Japan)*

Nisshin Seiko Giho
*Nisshin Seiko Giho (Technical Report of Nisshin Steel Co., Ltd.) *(Japan)*

Nagoya Med. J.
*Nagoya Medical Journal *(Japan)*

Nogyo Oyobi Engei
*Nogyo Oyobi Engei (Agriculture and Horticulture) *(Japan)*

Non-Destruct. Test.
*Non-Destructive Testing *(England)*

Nord. Med.
Nordisk Medicin *(Sweden)*

Norsk Skogind.
Norsk Skogindustri *(Norway)*

Nucl. India
Nuclear India *(India)*

Nucl. Law Bull.
*Nuclear Law Bulletin *(Belgium)*

Nucl. Law Bull., Suppl.
*Nuclear Law Bulletin, Supplement *(Belgium)*

Nukleonika, Supl.
*Nukleonika, Suplement *(Poland)*

N. Z. Dent. J.
New Zealand Dental Journal *(New Zealand)*

N. Z. J. Agr.
New Zealand Journal of Agriculture *(New Zealand)*

N. Z. Med. J., Suppl.
New Zealand Medical Journal, Supplement *(New Zealand)*

N. Z. Sci. Rev.
New Zealand Science Review *(New Zealand)*

Oceanogr. Mag.
Oceanographical Magazine, The *(Japan)*

Ochr. Pr.
Ochrona Pracy *(Poland)*

Odontol. Tidskr.
Odontologisk Tidskrift *(Sweden)*

Oftal'mol. Zh.
Oftal'mologicheskii Zhurnal *(Ukrainian S.S.R.)*

Ohio State Med. J.
Ohio State Medical Journal *(U. S.)*

Okajimas Folia Anat. Jap.
*Okajimas Folia Anatomica Japonica *(Japan)*

Okayama Daigaku Onsen Kenkyusho Hokoku
*Okayama Daigaku Onsen Kenkyusho Hokoku (Papers of the Inst. for Thermal Spring Research, Okayama University) *(Japan)*

Oncol. Radiol.
Oncologia si Radiologia *(Romania)*

Onde Elec., Suppl.
*Onde Electrique, L, Supplement *(France)*

Onsen Kagaku
*Onsen Kagaku (Journal of the Balneological Society of Japan) *(Japan)*

Onsen Kogakkaishi
*Onsen Kogakkaishi (Journal of the Society of Engineers for Mineral Springs, Japan) *(Japan)*

Opt.-Mekh. Prom.
Optiko-Mekhanicheskaya Promyshlennost *(U.S.S.R.)*

Ortop., Travmatol. Prot.
Ortopediya, Travmatologiya i Protezirovanie *(U.S.S.R.)*

Osaka Daigaku Shigaku Zasshi
*Osaka Daigaku Shigaku Zasshi (The Journal of Osaka University Dental Society) *(Japan)*

Osaka Furitsu Kogyo Shoreikan Hokoku
*Osaka Furitsu Kogyo Shoreikan Hokoku (Reports of Industrial Research Inst., Osaka Prefecture) *(Japan)*

Osaka Kogyo Gijutsu Shikenjo Kiho
Osaka Kogyo Gijutsu Shikenjo Kiho (Bulletin of the Government Industrial Research Institute, Osaka) *(Japan)*

Osaka Shiritsu Kogyo Kenkyusho Hokoku
*Osaka Shiritsu Kogyo Kenkyusho Hokoku (Bulletin of the Osaka Municipal Technical Research Inst.) *(Japan)*

Oto-Rhino-Laryngol. Clin.
Oto-Rhino-Laryngological Clinic
see *Jibiinkoka Rinsho*

Palaeogeogr., Palaeoclimatol., Palaeoecol.
Palaeogeography, Palaeoclimatology, Palaeoecology *(Netherlands)*

Paperboard Packag.
Paperboard Packaging *(U. S.)*

Paperi Puu-Lehdesta
Paperi ja Puu-Lehdesta *(Finland)*

Pap. Inst. Thermal Spring Res., Okayama Univ.
Papers of the Inst. for Thermal Spring Research, Okayama University
see *Okayama Daigaku Onsen Kenkyusho Hokoku*

Pediatrics, Suppl.
Pediatrics, Supplement *(U. S.)*

Pediatriya (Moscow)
Peditriya (Moscow) *(U.S.S.R.)*

Pei Ching Ta Hsueh Hsueh Pao, Tzu Jan K'o Hsueh
Pei Ching Ta Hsueh Hsueh Pao, Tzu Jan K'o Hsueh (Acta Scientiarum Naturalium Universitatis Pekinensis) *(China)*

Petrol Gaze
*Petrol si Gaze *(Romania)*

Photogr. Appl. Sci. Technol.
*Photographic Applications in Science and Technology *(U. S.)*

Phys. Bull. (London)

*Physics Bulletin (London) *(England)*
Phys. Chem. Liquids
Physics and Chemistry of Liquids *(England)*
Phys.-Diaet. Ther.
Physikalisch-Diaetetische Therapie *(West Germany)*
Phys. Earth Planet. Interiors
*Physics of the Earth and Planetary Interiors *(Netherlands)*
Pipes Pipelines Int.
Pipes and Pipelines International (formerly International Pipes and Pipelines) *(England)*
Piping Eng.
Piping Engineering, The
see ***Haikan Gijutsu***
Plant Breed. Abstr.
*Plant Breeding Abstracts *(England)*
Plant Cell Physiol. (Kyoto)
Plant and Cell Physiology (Kyoto) *(Japan)*
Plant Dis. Rep.
Plant Disease Reporter *(U. S.)*
Plant Physiol., Suppl.
*Plant Physiology, Supplement *(U. S.)*
Plastics (London)
*Plastics (London) *(England)*
Pol'nohospodarstvo
Pol'nohospodarstvo *(Czechoslovakia)*
Poluprov. Prib. Ikh Primen., Sb. Statei
Poluprovodnikovye Pribory i Ikh Primenenie, Sbornik Statei *(U.S.S.R.)*
Polym. Appl.
Polymer Application
see ***Kobunshi Kako***
Pop. Sci. (Peking)
Popular Science (Peking)
see ***K'o Hsueh To Chung***
Pororogurafii
Pororogurafii (Review of Polarography) *(Japan)*
Poznan. Tow. Przyj. Nauk, Wydz. Lek., Pr. Kom. Farm.
Poznanskie Towarzystwo Przyjaciol Nauk, Wydzial Lekarski, Prace Komisji Farmaceutycznej *(Poland)*
Praxis (Bern)
Praxis (Bern) *(Switzerland)*
Probl. Fiziol. Opt.
Problemy Fiziologicheskoi Optiki *(U.S.S.R.)*
Proc. Amer. Soc. Hort. Sci.
Proceedings of the American Society for Horticultural Science *(U. S.)*
Proc. Astron. Soc. Aust.
Proceedings of the Astronomical Society of Australia *(Australia)*
Proc. Crop Sci. Soc. Jap.
Proceedings of the Crop Science Society of Japan
see ***Nippon Sakumotsu Gakkai Kiji***
Proc. Egypt. Acad. Sci.
Proceedings of the Egyptian Academy of Sciences *(Egypt)*
Process Biochem.
Process Biochemistry *(England)*
Prochnost Din. Aviats. Dvigatelei
Prochnost i Dinamika Aviatsionnykh Dvigatelei *(U.S.S.R.)*
Proc. Indian Acad. Sci., Sect. B
Proceedings of the Indian Academy of Sciences, Section B *(India)*
Proc. Jap. Cem. Eng. Ass.
Proceedings of Japan Cement Engineering Association
see ***Semento Gijutsu Nenpo***
Proc. La. Acad. Sci.
*Proceedings of the Louisiana Academy of Sciences, The *(U. S.)*
Proc. Nat. Acad. Sci., India, Sect. A
Proceedings of the National Academy of Sciences, India, Section A *(India)*
Proc. Phys. Soc. (London)
Proceedings of the Physical Society (London) changed to Journal of Physics, A, B, and C *(England)*
Proc. Soc. Water Treat. Exam.
Proceedings of the Society for Water Treatment and Examination *(England)*
Proc. (Tr.) P. N. Lebedev Phys. Inst. (USSR) (Engl. Transl.)
Proceedings (Trudy) of the P. N. Lebedev Physics Institute (USSR) (English Translation of Trudy Fizicheskogo Instituta imeni P. N. Lebedeva, Akademiya Nauk SSSR) *(U. S.)*
Prod. Eng.
Product Engineering *(U. S.)*
Prod. Pharm.
Produits Pharmaceutiques *(France)*
Progr. Anal. Chem.
Progress in Analytical Chemistry *(U. S.)*
Progr. High Temp. Phys. Chem.
*Progress in High Temperature Physics and Chemistry *(England)*
Progr. Ind. Microbiol.
Progress in Industrial Microbiology *(U. S.–England)*
Progr. Nucl. Tech. Instrum.
Progress in Nuclear Techniques and Instrumentation *(Netherlands)*
Progr. Solid State Chem.
*Progress in Solid State Chemistry *(England)*
Progr. Stiintei
Progresele Stiintei *(Romania)*
Prot. Civ. Secur. Ind.
Protection Civile et Securite Industrielle *(France)*
Protein, Nucl. Acid, Enzyme
Protein, Nucleic Acid, Enzyme
see ***Tanpakushitsu Kakusan Koso***
Prum. Potravin
Prumysl Potravin *(Czechoslovakia)*
Przegl. Lek.
Przeglad Lekarski *(Poland)*
Przegl. Morski
Przeglad Morski *(Poland)*
PTB Mitt.
*PTB Mitteilungen. Amts- und Mitteilungsblatt der Physikalisch-Technischen Bundesanstalt *(West Germany)*
Pubb. Centro Sper. Agr. Forest.
Pubblicazioni del Centro di Sperimentazione Agricola e Forestale *(Italy)*
Quad. Nutr.
Quademi della Nutrizione *(Italy)*
Quart. Colo. Sch. Mines
Quarterly of the Colorado School of Mines *(U. S.)*
Queensland Govt. Mining J.
Queensland Government Mining Journal *(Australia)*
Radiat. Res. Rev.
Radiation Research Reviews *(Netherlands)*
Radio (China)
Radio (China)
see ***Wu Hsien Tien***
Radiobiol. Biol. Mol.
Radiobiologia si Biologia Moleculara *(Romania)*
Radiologia (Panama)
Radiologia *(Panama)*
Radioprotection
*Radioprotection. Bulletin de la Societe Francaise de Radioprotection *(France)*
Rad. Poljopr. Fak. Univ. Sarajevu
Radovi Poljoprivrednog Fakulteta Univerziteta u Sarajevu *(Yugoslavia)*
Rakuno Kagaku No Kenkyu
Rakuno Kagaku No Kenkyu (Japanese Journal of Dairy Science) *(Japan)*
Rast. Nauki
Rasteniev'dni Nauki *(Bulgaria)*
Razved. Okhr. Nedr
Razvedka i Okhrana Nedr *(U.S.S.R.)*
RCN (Reactor Cent. Ned.) Meded.
RCN (Reactor Centrum Nederland) Mededeling *(Netherlands)*
Reactor Fuel-Process. Technol.
*Reactor and Fuel-Processing Technology (A Quarterly Technical Progress Review) (formerly Power Reactor Technology and Reactor Fuel Processing) *(U. S.)*
Rec. Trav. Bot. Neer.
Recueil des Travaux Botaniques Neerlandais *(Netherlands)*
Refrigeration (Tokyo)
Refrigeration (Tokyo), The
see ***Reito***
Reito
Reito (The Refrigeration) *(Japan)*
Rend. Semin. Mat. Fis. Milano
Rendiconti del Seminario Matematico e Fisico di Milano *(Italy)*
Rep. Fac. Eng., Yamanashi Univ.
Reports of the Faculty of Engineering, Yamanashi University
see ***Yamanashi Daigaku Kogakubu Kenkyu Hokoku***
Rep. Fac. Sci., Shizuoka Univ.
*Reports of Faculty of Science, Shizuoka University *(Japan)*
Rep. Fire Res. Inst. Jap.
Report of Fire Research Inst. of Japan
see ***Shobo Kenkyusho Hokoku***
Rep. Hokkaido Inst. Public Health
Report of the Hokkaido Inst. of Public Health
see ***Hokkaidoritsu Eisei Kenkyusho***
Rep. Ind. Res. Inst., Osaka Prefect.
Reports of Industrial Research Inst., Osaka Prefecture
see ***Osaka Furitsu Kogyo Shoreikan Hokoku***

Rep. Nat. Res. Inst. Police Sci.
Reports of the National Research Inst. of Police Science
see Kagaku Keisatsu Kenkyusho Hokoku

Rep. Res. Inst. Ind. Safety
Reports of the Research Inst. of Industrial Safety
see Sangyo Anzen Kenkyusho Hokoku

Rep. Res. Inst. Sci. Ind., Kyushu Univ.
Reports of the Research Inst. of Science and Industry, Kyushu University
see Kyushu Daigaku Seisan Kagaku Kenkyusho Hokoku

Rep. Technol. Iwate Univ.
Report on Technology of Iwate University
see Iwate Daigaku Kogakubu Kenkyu Hokoku

Rep. Tokyo-to Lab. Med. Sci.
Report of Tokyo-to Lab. for Medical Sciences
see Tokyo Toritsu Eisei Kenkyusho Kenkyu Hokoku

Rep. Train. Inst. Eng. Teach., Kyoto Univ.
Report of the Training Inst. for Engineering Teachers, Kyoto University
see Kyoto Daigaku Kogyo Kyoin Yoseijo Kenkyu Hokoku

Res. Bull., Univ. Calcutta
Research Bulletin, University of Calcutta *(India)*

Res. Electrotech. Lab.
Researches of the Electrotechnical Laboratory
see Denki Shikenjo Kenkyu Hokoku

Res. Rep., Nagano Tech. Coll.
Research Reports, Nagano Technical College
see Nagano Kogyo Koto Senmon Gakko Kiyo

Rev. Acad. Cienc. Exactas, Fis.-Quim. Natur. Zaragoza
Revista de la Academia de Ciencias Exactas, Fisico-Quimicas y Naturales de Zaragoza *(Spain)*

Rev. Brasil. Quim. (Sao Paulo)
*Revista Brasileria de Quimica *(Brazil)*

Rev. Elec.
Revista Electricidade *(Portugal)*

Rev. Energ. Primaire
Revue Energie Primaire *(Belgium)*

Rev. Fac. Cienc. Agr., Min. Educ., Univ. Nac. Cuyo (Mendoza)
Revista de la Facultad de Ciencias Agrarias, Ministerio de Educacion, Universidad Nacional de Cuyo (Mendoza) *(Argentina)*

Rev. Fr. Elec.
*Revue Francaise de l'Electricite *(France)*

Rev. Fr. Odonto-stomatol.
Revue Francaise d'Odonto-stomatologie *(France)*

Rev. Gen. Caout. Plast.
Revue Generale du Caoutchouc et des Plastiques *(France)*

Rev. Gen. Therm.
Revue Generale de Thermique *(France)*

Rev. Geogr. Phys. Geol. Dyn.
Revue de Geographie Physique et de Geologie Dynamique *(France)*

Rev. Hosp. Clin., Fac. Med., Univ. Sao Paulo
Revista do Hospital das Clinicas, Faculdade de Medicina, Universidade de Sao Paulo *(Brazil)*

Rev. Interamer. Radiol.
Revista Interamericana de Radiologia *(Peru)*

Rev. Int. Oceanogr. Med.
*Revue Internationale d'Oceanographie Medicale *(France)*

Rev. Invest. Agropecuar., Ser. 4
Revista de Investigaciones Agropecuarias, Serie 4. Patologia Animal *(Argentina)*

Rev. Laryngol., Otol., Rhinol., Suppl.
Revue de Laryngologie, Otologie, Rhinologie, Supplement *(France)*

Rev. Latinoamer. Microbiol. Parasitol.
Revista Latinoamericana de Microbiologia y Parasitologia (formerly Revista Latinoamericana de Microbiologia) *(Mexico)*

Rev. Polarogr. (Jap.)
Review of Polarography (Japan)
see Proarografii

Rev. Real Acad. Cienc. Exact., Fis. Nat. Madrid
Revista de la Real Academia de Ciencias Exactas, Fisicas y Naturales de Madrid *(Spain)*

Rev. Roum. Math. Pures Appl.
Revue Roumaine de Mathematiques Pures et Appliquees *(Romania)*

Rev. Roum. Sci. Tech., Ser. Mecan. Appl.
Revue Roumaine des Sciences Techniques, Serie de Mecanique Appliquee *(Romania)*

Rev. Sanid. Mil. Argent.
Revista de la Sanidad Militar Argentina *(Argentina)*

Rev. Soudure (Brussels)
Revue de la Soudure (Brussels) *(Belgium)*

Rev. Stomatol.
Revue de Stomatologie *(France)*

Rev. Zootch. Med. Vet.
Revista de Zootehnic si Medicina Veterinara *(Romania)*

Rheol. Acta
Rheologica Acta *(West Germany)*

Riv. Crit. Clin. Med.
Rivista Critica di Clinica Medica *(Italy)*

Riv. Mineraria Sicil.
Rivista Mineraria Siciliana *(Italy)*

Riv. Parassitol.
Rivista di Parassitologia *(Italy)*

Roczn. Akad. Med. Bialymstoku
Roczniki Akademii Medycznej im. Juliana Marchlewskiego w Bialymstoku *(Poland)*

Rom. Med. Rev.
Romania Medical Review *(Romania)*

Roy. Observ. Bull.
Royal Observatory Bulletins *(England)*

Roy. Soc. Health J.
Royal Society of Health Journal *(England)*

Rudarsko-Met. Zbornik, Suppl.
Rudarsko-Metalurski Zbornik, Supplement *(Yugoslovia)*
For English Translation see Mining Met. Quart., Suppl.

Rudodobiv Met. (Sofia)
Rudodobiv i Metalurgiya (Sofia) *(Bulgaria)*

Ruimtevaart
Ruimtevaart *(Netherlands)*

RUM, Rev. Universelle Mines
RUM, Revue Universelle des Mines, de la Metallurgie, de la Mecanique, des Travaux Publics, des Sciences et des Arts Appliques a l'Industrie (formerly Revue Universelle des Mines, de la Metallurgie, de la Mecanique, des Travaux Publics, des Sciences et des Arts Appliques a l'Industrie) *(Belgium)*

Russ. Chem. Rev. (Engl. Transl.)
Russian Chemical Reviews (English Translation of Uspekhi Khimii) *(England)*

S. Afr. Mech. Eng.
South African Mechanical Engineer, The *(South Africa)*

Sakh. Prom.
Sakhamaya Promyshlennost *(U.S.S.R.)*

Salt Res. Ind. (Bhavnagar, India)
Salt Research and Industry (Bhavnagar, India) *(India)*

Samoletostr. Tekh. Vozdush. Flota
Samoletostroenie i Tekhnika Vozdushnogo Flota *(U.S.S.R.)*

Sangyo Anzen Kenkyusho Hokoku
*Sangyo Anzen Kenkyusho Hokoku (Reports of the Research Inst. of Industrial Safety) *(Japan)*

Sangyo Igaku
Sangyo Igaku (Japanese Journal of Industrial Health) *(Japan)*

Sankyo Kenkyusho Nenpo
*Sankyo Kenkyusho Nenpo (Annual Report of Sankyo Research Laboratory) *(Japan)*

Savremena Poljopr.
Savremena Poljoprivreda *(Yugoslavia)*

Sb. Geol. Ved, Uzita Geofyz.
Sbornik Geologickych Ved, Uzita Geofyzika *(Czechoslovakia)*

Sb. Ved. Pr. Lek. Fak. Karlovy Univ. Hradci Kralove, Suppl.
Sbornik Vedeckych Praci Lekarske Fakulty Karlovy University v Hradci Kralove, Supplementum *(Czechoslovakia)*

Scand. J. Clin. Lab. Invest., Suppl.
Scandinavian Journal of Clinical and Laboratory Investigation, Supplement *(Sweden)*

Schweiz. Arch. Tierheilk.
Schweizer Archiv fuer Tierheilkunde *(Switzerland)*

Schweiz. Muenzbl.
Schweizer Muenzblaetter *(Switzerland)*

Sci. Avenir
Sciences et Avenir *(France)*

Sci. Bull. Fac. Agr., Kyushu Univ.
Science Bulletin of the Faculty of Agriculture, Kyushu University
see Kyushu Daigaku Nogakubu Gakugei Zasshi

Sciences (Paris)
Sciences et l'Enseignement des Sciences (Paris) *(France)*

Sci. Forum
Science Forum *(Canada)*

Sci. Ind. Spatiales
Sciences et Industries Spatiales *(Switzerland)*

Sci. News (Wash., D. C.)
Science News (Washington, D. C.) *(U. S.)*

Sci. Proc. Roy. Dublin Soc., Ser. A
*Scientific Proceedings of the Royal Dublin Society, The, Series A (supersedes The Scientific Proceedings of the Royal Dublin Society, New Series) *(Ireland)*

Sci. Publ. Fuji Photo Film Co., Ltd.

Scientific Publications of the Fuji Photo Film Co., Ltd.
see *Fuji Shashin Fuirumu Kenkyu Hokoku*

Sci. Rep., Coll. Gen. Educ., Osaka Univ.
Science Report, College of General Education, Osaka University *(Japan)*

Sci. Rep. Niigata Univ., Ser. B
*Science Reports of Niigata University, Series B. Physics *(Japan)*

Sci. Rep. Tohoku Univ., Third Ser.
*Science Reports of the Tohoku University, Third Series. Mineralogy, Petrology and Economic Geology *(Japan)*

Sci. Technol. (N. Y.)
*Science and Technology (New York) *(U. S.)*

Scot. J. Polit. Econ.
Scottish Journal of Political Economy *(Scotland)*

Scr. Met.
*Scripta Metallurgica *(U. S.)*

Seimitsu Kikai
Seimitsu Kikai (Journal of the Society for Precision Mechanics of Japan) *(Japan)*

Sekiyu Gakkaishi
*Sekiyu Gakkaishi (Journal of the Japan Petroleum Institute) *(Japan)*

Semento Gijutsu Nenpo
Semento Gijutsu Nenpo (Proceedings of Japan Cement Engineering Association) *(Japan)*

Seminars Hematol.
*Seminars in Hematology *(U. S.)*

Seminars Roentgenol.
Seminars in Roentgenology *(U. S.)*

Sen'i Gakkaishi
*Sen'i Gakkaishi (Journal of the Society of Fiber Science and Technology, Japan) *(Japan)*

Ser. Haematol.
Series Haematologica (Supplements Scandinavia Journal of Haematology) *(Denmark)*

Sheet Metal Ind.
Sheet Metal Industries *(England)*

Shimazu Hyoron
*Shimazu Hyoron (Shimazu Review) *(Japan)*

Shimazu Rev.
Shimazu Review
see *Shimazu Hyoron*

Shionogi Kenkyusho Nenpo
*Shionogi Kenkyusho Nenpo (Annual Report of Shionogi Research Laboratory) *(Japan)*

Shipping World Shipbuilder
Shipping World and Shipbuilder *(England)*

Shiritsu Sapporo Byoin Ishi
*Shiritsu Sapporo Byoin Ishi (The Journal of Sapporo Municipal General Hospital (Acta Medica Nosocomi Sapporo)) *(Japan)*

Shobo Kenkyusho Hokoku
*Shobo Kenkyusho Hokoku (Report of Fire Research Inst. of Japan) *(Japan)*

Shokubai
*Shokubai (Catalyst) *(Japan)*

Shokuhin Eiseigaku Zasshi
*Shokuhin Eiseigaku Zasshi (Journal of the Food Hygienic Society of Japan) *(Japan)*

Showa Densen Denran Rebyu
*Showa Densen Denran Rebyu (Showa Wire and Cable Review) *(Japan)*

Showa Wire Cable Rev.
Showa Wire and Cable Review
see *Showa Densen Denran Rebyu*

Sichere Arb.
Sichere Arbeit *(Austria)*

Silicates Ind.
Silicates Industriels *(Belgium)*

Silikaty
Silikaty *(Czechoslovakia)*

Slaboproudy Obz.
Slaboproudy Obzor *(Czechoslovakia)*

S. Lumberman
Southern Lumberman *(U. S.)*

Soc. Petrol. Eng. J.
Society of Petroleum Engineers Journal, The *(U. S.)*

Soil Crop Sci. Soc. Fla., Proc.
Soil and Crop Science Society of Florida, Proceedings *(U. S.)*

Soils (Peking)
Soils (Peking)
see *T'u Jang*

Solar Syst. Res. (USSR) (Engl. Transl.)
Solar Systems Research (USSR) (English Translation of Astronomicheskii Vestnik) *(U. S.)*

Solid State Technol.
Solid State Technology *(U. S.)*

Soln. Dannye
Solnechnyie Dannye *(U.S.S.R.)*

Soobshch. Shemakhinskoi Astrofiz. Observ., Akad. Nauk Azerb. SSR
*Soobshcheniya Shemakhinskoi Astrofizicheskoi Observatorii, Akademiya Nauk Azerbaidzhanskoi SSR *(Azerbaidzhan S.S.R.)*

Southwest. Med.
Southwestern Medicine *(U. S.)*

Southwest. Natur.
Southwestern Naturalist *(U. S.)*

Sov. Antarct. Exped. Inform. Bull.
Soviet Antarctic Expedition Information Bulletin (English Translation of Informatsionnyi Byulleten Sovetskoi Antarkticheskoi Ekspeditsii) *(U. S.)*

Sov. Med.
Sovetskaya Meditsina *(U.S.S.R.)*

Sov. Phys.-Semicond. (Engl. Transl.)
Soviet Physics-Semiconductors (English Translation of Fizika i Tekhnika Poluprovodnikov) *(U. S.)*

Space Biol. Med. (USSR) (Engl. Transl.)
Space Biology and Medicine (USSR) (English Translation of Kosmicheskaya Biologiya i Meditsina) *(U.S.)*

Space Life Sci.
Space Life Sciences *(Netherlands)*

Spectrum (Oxford)
Spectrum (Oxford) *(England)*

Spis. Bulg. Akad. Nauk.
Spisanie na Bulgarskata Akademiya na Naukite *(Bulgaria)*

SRW (Siemens-Reiniger-Werke) Nachr.
SRW (Siemens-Reiniger-Werke) Nachricht *(West Germany)*

Ssu Ch'uan Ta Hsueh Hsueh Pao—Tzu Jan K'o Hsueh
Ssu Ch'uan Ta Hsueh Hsueh Pao—Tzu Jan K'o Hsueh (Acta Scientiarum Naturalium, Universitatis Szechuanensis) *(China)*

Stainless (Tokyo)
Stainless, The (Tokyo)
see *Sutenresu*

Stain Technol.
Stain Technology *(U. S.)*

Steel Times
Steel Times *(England)*

Strahlenschutz Forsch. Prax.
Strahlenschutz in Forschung und Praxis *(West Germany)*

Strain
Strain *(England)*

Strait. Mater.
Straitel'nye Materialy *(U.S.S.R.)*

Stud. Cercet. Endocrinol.
Studii si Cercetari de Endocrinologie *(Romania)*

Stud. Cercet. Energ. Electrotek.
Studii si Cercetari de Energetica si Electrotehnica *(Romania)*

Stud. Cosmic Ray
Studies of Cosmic Ray
see *Uchusen Kenkyu*

Sumitomo Kinzoku
*Sumitomo Kinzoku (Sumitomo Metals) *(Japan)*

Sumitomo Metals
Sumitomo Metals
see *Sumitomo Kinzoku*

Surv. Mapp.
Surveying and Mapping *(U. S.)*

Sutenresu
Sutenresu (The Stainless) *(Japan)*

Svetsaren Engl.
Svetsaren in English *(Sweden)*

Sv. Lakartidn.
Svenska Lakartidningen *(Sweden)*

Sv. Naturvetensk.
Svensk Naturvetenskap *(Sweden)*

Symp. Soc. Exp. Biol.
Symposia of the Society for Experimental Biology *(England)*

Tagungsber., Deut. Akad. Landwirtschaftswiss. Berlin
Tagungsberichte, Deutsche Akademie der Landwirtschaftswissenschaften zu Berlin *(East Germany)*

T'ai-wan I Hsueh Hui Tsa Chih
T'ai-wan I Hsueh Hui Tsa Chih (Journal of the Formosan Medical Association) *(China (Taiwan))*

Tanpakushitsu Kakusan Koso
Tanpakushitsu Kakusan Koso (Protein, Nucleic Acid, Enzyme) *(Japan)*

Tech. Dig. (Prague)
Technical Digest (Prague), Statni Nakladatelstvi Technicke Literatury *(Czechoslovakia)*

Tech. Lab., Cent. Res. Inst. Elec. Power Ind., Rep.
Technical Laboratory, Central Research Institute of Electrical

Power Industry, Report
see ***Denryoku Chuo Kenkyusho Gijutsu Kenkyusho Hokoku***

Tech. Mitt. AEG-Telefunken
*Technische Mitteilungen AEG-Telefunken (a continuation of AEG-Mitteilungen) *(West Germany)*

Technik (Berlin)
Technik (Berlin), Die *(East Germany)*

Technology (Sindri)
Technology (Sindri). Quarterly Bulletin of the Planning and Development Div., Fertilizer Corp. of India Ltd. *(India)*

Technol. Rep. Kyushu Univ.
Technology Reports of the Kyushu University
see ***Kyushu Daigaku Kogaku Shuho***

Tech. Note Port Harbour Tech. Res. Inst., Min. Transp., Jap.
Technical Note of Port and Harbour Technical Research Inst., Ministry of Transporation, Japan
see ***Kowan Giken Shiryo***

Tech. Petrole
Techniques du Petrole *(France)*

Tech. Rep. ISSP (Inst. Solid State Phys.), Ser. A
*Technical Report of ISSP (Inst. for Solid State Physics), Series A *(Japan)*

Tech. Rep. Kumamoto Univ.
Technical Reports of the Kumamoto University
see ***Kumamoto Daigaku Kogakubu Kenkyu Hokoku***

Tech. Rep. Nisshin Steel Co., Ltd.
Technical Report of Nisshin Steel Co., Ltd.
see ***Nisshin Seiko Giho***

Tech. Sci. Aeronaut. Spatiales
Technique et Science Aeronautiques et Spatiales *(France)*

Tec. Ital.
Tecnica Italiana *(Italy)*

Tekhnol. Organ. Proizvod.
Tekhnologiya i Organizatsiya Proizvodstva *(Ukrainian S.S.R.)*

Tekst. Prom.
Tekstil'naya Promyshlennost *(U.S.S.R.)*

Teor. Prakt. Met., Sov. Nar. Khoz. Chelyabinsk. Ekon. Admin. Raiona, Nauch.-Issled. Inst. Met.
Teoriya i Praktika Metallurgii, Sovet Narodnogo Khozyaistva Chelyabinskogo Ekonomicheskogo Administrativnogo Raiona, Nauchno-Issledovatel'skii Institut Metallurgii *(U.S.S.R.)*

Terapia (Milan)
Terapia (Milan) *(Italy)*

Terapia (Turin)
Terapia (Turin) *(Italy)*

Therapiewoche
Therapiewoche *(West Germany)*

Ther. Woche
Therapie Woche, Die *(West Germany)*

Thin Solid Films
*Thin Solid Films *(Netherlands)*

Thoraxchir. Vask. Chir.
Thoraxchirurgie und Vaskulaere Chirurgie (formerly Thoraxchirurgie) *(West Germany)*

Tidschr. Diergeneesk.
Tidschrift voor Diergeneeskunde *(Netherlands)*

Tidskr. Dok. (Swed.)
Tidskrift for Dokumentation *(Sweden)*

Tien Shih Chieh
Tien Shih Chieh (Electrical World) *(China)*

Tijdschr. Primaire Energ.
Tijdschrift Primaire Energie
see ***Rev. Energ. Primaire***

Timisoara Med.
*Timisoara Medicala *(Romania)*

Tohoku Daigaku Kagaku Keisoku Kenkyusho Hokoku
Tohoku Daigaku Kagaku Keisoku Kenkyusho Hokoku (Bulletin of the Research Institute for Scientific Measurements, Tohoku University) *(Japan)*

Tohoku Daigaku Senko Seiren Kenkyusho Iho
*Tohoku Daigaku Senko Seiren Kenkyusho Iho (Bulletin of the Research Inst. of Mineral Dressing and Metallurgy, Tohoku University) *(Japan)*

Tohoku Igaku Zasshi
*Tohoku Igaku Zasshi (Tohoku Medical Journal) *(Japan)*

Tohoku Med. J.
Tohoku Medical Journal
see ***Tohoku Igaku Zasshi***

Tokyo Astron. Bull., Ser. II
Tokyo Astronomical Bulletin, Series II *(Japan)*

Tokyo Daigaku Jishin Kenkyusho Iho
Tokyo Daigaku Jishin Kenkyusho Iho (Bulletin of the Earthquake Research Inst., University of Tokyo) *(Japan)*

Tokyo Daigaku Uchu Koku Kenkyusho Hokoku
*Tokyo Daigaku Uchu Kenkyusho Hokoku (Bulletin of the Institute of Space and Aeronautical Science, University of Tokyo) *(Japan)*

Tokyo Igaku Zasshi
*Tokyo Igaku Zasshi (The Tokyo Journal of Medical Sciences) *(Japan)*

Tokyo Jikeikai Ika Daigaku Zasshi
*Tokyo Jikeikai Ika Daigaku Zasshi (Tokyo Jikeikai Medical Journal) *(Japan)*

Tokyo Jikeika Med. J.
Tokyo Jikeikai Medical Journal
see ***Tokyo Jikeikai Ika Daigaku Zasshi***

Tokyo J. Med. Sci.
Tokyo Journal of Medical Sciences, The
see ***Tokyo Igaku Zasshi***

Tokyo Joshi Ika Daigaku Zasshi
*Tokyo Joshi Ika Daigaku Zasshi (Journal of Tokyo Women's Medical College) *(Japan)*

Tokyo Toritsu Eisei Kenkyusho Kenkyu Hokoku
*Tokyo Toritsu Eisei Kenkyusho Kenkyu Hokoku (Report of Tokyo-to Lab. for Medical Sciences) *(Japan)*

Tonind.-Ztg. Keram. Rundsch.
Tonindustrie-Zeitung und Keramische Rundschau *(West Germany)*

Trans. Amer. Ophthalmol. Soc.
Transactions of the American Ophthalmological Society *(Canada)*

Trans. Indian Ceram. Soc.
Tranactions of the Indian Ceramic Society *(India)*

Trans. Ing.
*Transactions. Ingenioeren *(Denmark)*

Trans. Inst. Metal Finish.
Transactions of the Institute of Metal Finishing *(England)*

Trans. Pac. Coast Obstet. Gynecol. Soc.
Transactions of the Pacific Coast Obstetrical and Gynecological Society *(U. S.)*

Transp. Stroit.
Transportnoe Stroitel'stvo *(U.S.S.R.)*

Trans. Soc. Instrum. Contr. Eng.
*Transactions of the Society of Instrument and Control Engineers *(Japan)*

Trans. Soc. Pathol. Jap.
Transactiones Societatis Pathologicae Japonicae
see ***Nippon Byori Gakkai Kaishi***

Tr. Arkt. Antarkt. Nauch.-Issled.
Trudy Arkticheskogo i Antarkticheskogo Nauchno-Issledovatel'skogo Instituta *(U.S.S.R.)*

Travaux
Travaux *(France)*

Tr. Gos. Gidrol. Inst.
Trudy Gosudarstvennogo Gidrologicheskogo Instituta *(U.S.S.R.)*

Tr. Gos. Issled. Elektrokerom. Inst.
Trudy Gosudarstvennogo Issledovatel'skogo Elektrokeramicheskogo Instituta *(U.S.S.R.)*

Tr., Gos. Nauch.-Issled. Proekt. Inst. Splavov Obrab. Tsvet. Metal.
Trudy, Gosudarstvennyi Nauchno-Issledovatel'skii i Proektnyi Institut Splavov i Obrabotki Tsvetnykh Metallov *(U.S.S.R.)*

Tr. Inst. Biol., Akad. Nauk SSSR, Ural. Filial
Trudy Instituta Biologii, Akademiya Nauk SSSR, Ural'skii Filial *(U.S.S.R.)*

Tr. Inst. Ekol. Rast. Zhivotn.
Trudy Instituta Ekologii Rastenii i Zhivotnykh *(U.S.S.R.)*

Tr. Inst. Eksp. Med. Akad. Med. Nauk SSSR
Trudy Instituta Eksperimental'noi Meditsiny Akademii Meditsinskikh Nauk SSSR *(U.S.S.R.)*

Tr. Inst. Khim., Akad. Nauk SSSR, Ural. Filial
Trudy Instituta Khimii, Akademiya Nauk SSSR, Ural'skii Filial *(U.S.S.R.)*

Tr. Inst. Met. Obogashch., Akad. Nauk Kaz. SSR
Trudy Instituta Metallurgii i Obogashcheniya, Akademiya Nauk Kazakhskoi SSR *(Kazakh S.S.R.)*

Tr. Kaz. Nauch.-Issled. Inst. Onkol. Radiol.
Trudy Kazakhskogo Nauchno-Issledovatel'skogo Instituta Onkologii i Radiologii *(Kazakh S.S.R.)*

Tr. Kom. Anal. Khim. Akad. Nauk SSSR, Inst. Geokhim. Anal. Khim.
Trudy Komissi po Analiticheskoi Khimii Akademiya Nauk SSSR, Institut Geokhimii i Analiticheskoi Khimii imeni V. I. Vernadskogo *(U.S.S.R.)*

Tr. Kom. Spektrosk., Akad. Nauk SSSR
Trudy Komissii po Spektroskopii, Akademiya Nauk SSSR *(U.S.S.R.)*

Tr. Lab. Ionoobmen. Protsessov Sorbtsii, Nauch.-Issled. Fiz.-Khim. Inst., Voronezh. Gos. Univ.
Trudy Laboratorii Ionoobmennykh Protsessov i Sorbtsii, Nauchno-Issledovatel'skii Fiziko-Khimicheskii Institut, Voronezhskii Gosudarstvennyi Universitet *(U.S.S.R.)*

Tr. Leningrad. Tekhnol. Inst. Tsellyul.-Bum. Prom.
Trudy Leningradskogo Tekhnologicheskogo Instituta Tsellyulozno-Bumazhnoi Promyshlennosti *(U.S.S.R.)*

Tr., Mosk. Aviats. Tekhnol. Inst.
Trudy, Moskovskii Aviatsionnyi Tekhnologicheskii Institut *(U.S.S.R.)*

Tr. Mosk. Vet. Akad.
Trudy Moskovskoi Veterinarnoi Akademii *(U.S.S.R.)*

Tr. Prikl. Bot. Genet. Selek.
Trudy po Prikladnoi Botanike, Genetike i Selektsii *(U.S.S.R.)*

Tr. Sib. Tekhnol. Inst.
Trudy Sibirskogo Tekhnologicheskogo Instituta *(U.S.S.R.)*

Tr. Sov. Antarkt. Eksped.
Trudy Sovetskoi Antarkticheskoi Ekspeditsii *(U.S.S.R.)*

Tr. Soyuznogo Nauch.-Issled. Inst. Priborostr.
Trudy Soyuznogo Nauchno-Issledovatel'skogo Instituta Priborostroeniya *(U.S.S.R.)*

Tr. Tashkent. Gos. Univ.
Trudy Tashkentskogo Gosudarstvennogo Universiteta im. V. I. Lenina *(U.S.S.R.)*

Tr. Teor. Polya
Trudy po Teorii Polya *(U.S.S.R.)*

TRW Space Log
*TRW Space Log *(U. S.)*

T'u Jang
T'u Jang (Soils) *(China)*

Tumor Res.
Tumor Research *(Japan)*

Tungsten News
*Tungsten News *(U.S.)*

T Z Prakt. Metallbearb.
T Z fuer Praktische Metallbearbeitung *(West Germany)*

Uchusen Kenkyu
Uchusen Kenkyu (Studies of Cosmic Ray) *(Japan)*

Uch. Zap. Kazan. Vet. Inst.
Uchenye Zapiski Kazanskogo Veterinarnogo Instituta *(U.S.S.R.)*

Umsch. Wiss. Tech.
*Umschau in Wissenschaft und Technik *(West Germany)*

Union Burma J. Life Sci.
*Union of Burma Journal of Life Sciences *(Burma)*

Univ. Kans. Sci. Bull.
University of Kansas Science Bulletin *(U. S.)*

Univ. Mich. Med. Cent. J.
University of Michigan Medical Center Journal *(U. S.)*

Univ. Roorkee, Res. J.
University of Roorkee, Research Journal *(India)*

Upr. Yadern. Energ. Ustanovkami, Sb. Statei
*Upravlenie Yadernymi Energeticheskimi Ustanovkami, Moskovskii Inzhenerno-Fizicheskii Institut, Sbornik Statei *(U.S.S.R.)*

U. S. Nav. Inst., Proc.
United States Naval Institute, Proceedings *(U. S.)*

Va. Med. Mon.
Virginia Medical Monthly *(U. S.)*

Vector (Baltimore)
Vector (Baltimore) *(U. S.)*

Ved. Pr. Vyzk. Ustavu Vet. Lek. Brne
Vedecke Prace Vyzkumneho Ustavu Veterinarniho Lekarstvi v Brne (superseded by Documenta Veterinaria) *(Czechoslovakia)*

Verh. Kon. Vlaam. Acad. Wetensch., Belg., Kl. Wetensch.
Verhandelingen van de Koninklijke Vlaamse Academie voor Wetenschappen, Letteren en Schone Kunsten van Belgie, Klasse der Wetenschappen *(Belgium)*

Veroeff. Morphol. Pathol.
Veroeffentlichungen aus der Morphologischen Pathologie *(West Germany)*

Verpakking
Verpakking *(Netherlands)*

Vestn. Cesk. Spolecnosti Zool.
Vestnik Ceskoslovenske Spolecnosti Zoologicke *(Czechoslovakia)*

Vestn. Leningrad. Univ., Ser. Biol.
Vestnik Leningradskogo Universiteta, Seriya Biologii *(U.S.S.R.)*

Vestn. Mosk. Univ., Ser. I, Mat., Mekh.
Vestnik Moskovskogo Universiteta, Seriya I, Matematika, Mekhanika *(U.S.S.R.)*

Vestn. Mosk. Univ., Ser. IV. Geol.
Vestnik Moskovskogo Universiteta, Seriya IV. Geologiya *(U.S.S.R.)*

Vestn. Sel'skokhoz. Nauki (Moscow)
Vestnik Sel'skokhozyaistvennoi Nauki (Moscow) *(U.S.S.R.)*

Vestn. Ustred. Ustavu Geol.
Vestnik Ustredniho Ustavu Geologickeho *(Czechoslovakia)*

Vet. Med. Nauki (Sofia)
Veterinarno Meditsinski Nauki (Sofia), Izvestiya na Akademiyata na Selskostopanskite Nauki *(Bulgaria)*

Vierteljahrsschr. Schweiz. Sanitaetsoffiz.
Vierteljahrsschrift fuer Schweizerische Sanitaetsoffiziere *(Switzerland)*

Visn. L'viv. Derzh. Univ., Ser. Khim.
Visnik L'vivs'kogo Derzhavnogo Universitetu im. Ivana Franka, Seriya Khimichna *(Ukrainian S.S.R.)*

Vodosnabzh. Sanit. Tekh.
Vodosnabzhenie i Sanitarnaya Tekhnika *(U.S.S.R.)*

Vojnoekon. Pregl.
Vojnoekonomski Pregled *(Yugoslavia)*

Vojnosanit. Pregl.
Vojnosanitetski Pregled *(Yugoslavia)*

Volt, Elec. Trade Mon.
Volt, Electrical Trade Monthly *(Japan)*

Vop. Eksp. Klin. Radiol., Khar'kov. Inst. Med. Radiol.
Voprosy Eksperimental'noi i Klinicheskoi Radiologii, Khar'kovskii Institut Meditsinskoi Radiologii *(Ukrainian S.S.R.)*

Waldhygiene
Waldhygiene *(West Germany)*

Water Res.
*Water Research (supersedes in part Air and Water Pollution) *(England)*

Water Waste Treat.
Water and Waste Treatment *(England)*

Wear
Wear *(Netherlands)*

Weld. Eng.
Welding Engineer *(U. S.)*

Weld. Res. Counc. Bull.
Welding Research Council Bulletin *(U. S.)*

Wiad. Hutn.
Wiadomosci Hutnicze *(Poland)*

Wien. Z. Inn. Med. Grenzgeb.
Wiener Zeitschrift fuer Innere Medizin und ihre Grenzgebiete *(Austria)*

Wis. Med. J.
Wisconsin Medical Journal *(U. S.)*

Wiss. Z. Ernst-Moritz-Arndt-Univ. Greifswald, Math.-Naturwiss. Reihe
Wissenschaftliche Zeitschrift der Ernst-Moritz-Arndt-Universitaet Greifswald, Mathematisch-Naturwissenschaftliche Reihe *(East Germany)*

Wiss. Z. Humboldt-Univ. Berlin, Math.-Naturwiss. Reihe
Wissenschaftliche Zeitschrift der Humboldt-Universitaet zu Berlin, Mathematisch-Naturwissenschaftliche Reihe *(East Germany)*

Wonjaryogwon. Yon'gu Nonmun Chip
Wonjaryogwon. Yon'gu Nonmun Chip
see J. Nucl. Sci. (Seoul)

World Meteorol. Organ. Bull.
*World Meteorological Organization Bulletin *(Switzerland)*

World Mining
World Mining *(U. S.)*

Wszechswiat
Wszechswiat *(Poland)*

Wu Han Ta Hsueh, Tzu Jan K'o Hsueh Hsueh Pao
Wu Han Ta Hsueh, Tzu Jan K'o Hsueh Hsueh Pao (Wuhan University Journal, Natural Sciences) *(China)*

Wuhan Univ. J., Natur. Sci.
Wuhan University Journal, Natural Sciences
see Wu Han Ta Hsueh, Tzu Jan K'o Hsueh Hsueh Pao

Wu Hsien Tien
Wu Hsien Tien (Radio) *(China)*

Yaderno-Geofiz. Issled., Geofiz. Sb.
Yaderno-Geofizicheskie Issledovaniya, Geoficicheskii Sbornik *(U.S.S.R.)*

Yadern. Priborostr., Nauch.-Tekh. Sb.
Yadernoe Priborostroenie, Nauchno-Tekhnicheskii Sbornik *(U.S.S.R.)*

Yakugaku Kenkyu
*Yakugaku Kenkyu (Japanese Journal of Pharmacy and Chemistry) *(Japan)*

Yamagata Daigaku Kiyo, Shizenkagaku
Yamagata Daigaku Kiyo, Shizenkagaku (Bulletin of the Yamagata University, Natural Science) *(Japan)*

Yamanashi Daigaku Hakko Kenkyusho Kenkyu Hokoku
*Yamanashi Daigaku Hakko Kenkyusho Kenkyu Hokoku (Bulletin of the Research Inst. of Fermentation, Yamanashi University) *(Japan)*

Yamanashi Daigaku Kogakubu Kenkyu Hokoku
*Yamanashi Daigaku Kogakubu Kenkyu Hokoku (Reports of the Faculty of Engineering, Yamanashi University) *(Japan)*

Yuan Tzu Nong
Yuan Tzu Nong (Atomic Energy) *(China)*
Zap. Leningrad. Gorn. Inst.
Zapiski Leningradskogo Gornogo Instituta *(U.S.S.R.)*
Zem. Beton
Zement und Beton *(Austria)*
Zemlya Vselennaya
Zemlya i Vselennaya *(U.S.S.R.)*
Zentralbl. Neurochir.
Zentralblatt fuer Neurochirurgie *(East Germany)*
Z. Ernaehrungswiss., Suppl.
Zeitschrift fuer Ernaehrungswissenschaft, Supplementa *(West Germany)*
Zesz. Nauk. Politech. Slaska, Energ.
Zeszyty Naukowe Politechnika Slaska, Energetyka *(Poland)*
Zh. Org. Khim.
*Zhurnal Organicheskoi Khimii *(U.S.S.R.)*
Z. Immunitaetsforsch., Allergie Klin. Immunol.
Zeitschrift fuer Immunitaetsforschung, Allergie und Klinische Immunologie *(West Germany)*
Z. Kinderheilk.
Zeitschrift fuer Kinderheilkunde *(West Germany)*
Z. Math. Phys.
Zeitschrift fuer Mathematik und Physik *(East Germany)*
Z. Mikrosk.-Anat. Forsch.
Zeitschrift fuer Mikroskopisch-Anatomische Forschung (Abt. 2 of Jahrbuch fuer Morphologie und Mikroskopische Anatomie) *(East Germany)*
Z. Morphol. Oekol. Tiere
Zeitschrift fuer Morphologie und Oekologie der Tiere *(West Germany)*
Zolnierz Pol.
Zolnierz Polski *(Poland)*
Zoologica (Seoul)
Zoologica (Seoul) *(South Korea)*
Zool. Zh.
Zoologicheskii Zhurnal *(U.S.S.R.)*
Z. Parasitenk.
Zeitschrift fuer Parasitenkunde *(West Germany)*
Z. Phys. Chem. B
Zeitschrift fuer Physikalische Chemie. Abt. B *(Germany)*
Z. Psychol. Physiol. Sinnesorg.
Zeitschrift fuer Psychologie und Physiologie der Sinnesorgane *(East Germany)*
Z. Sinnephysiol.
Zeitschrift fuer Sinnephysiologie *(East Germany)*
Z. Tech. Ueberwach.
Zeitschrift Technische Ueberwachung *(Austria)*
Z. Urol. Nephrol.
Zeitschrift fuer Urologie und Nephrologie *(East Germany)*
Z. Wiss. Mikrosk.
Zeitschrift fuer Wissenschaftliche Mikroskopie und fuer Mikroskopische Technik *(West Germany)*

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NOTICE

A title page for Volume 22, Numbers 19–24, is included at the back of this issue for use in binding those issues.

CORRECTION

NSA Vol. 22, No. 9, Abst. No. 16997, line 7 should read: 172p. (CONF-660346).